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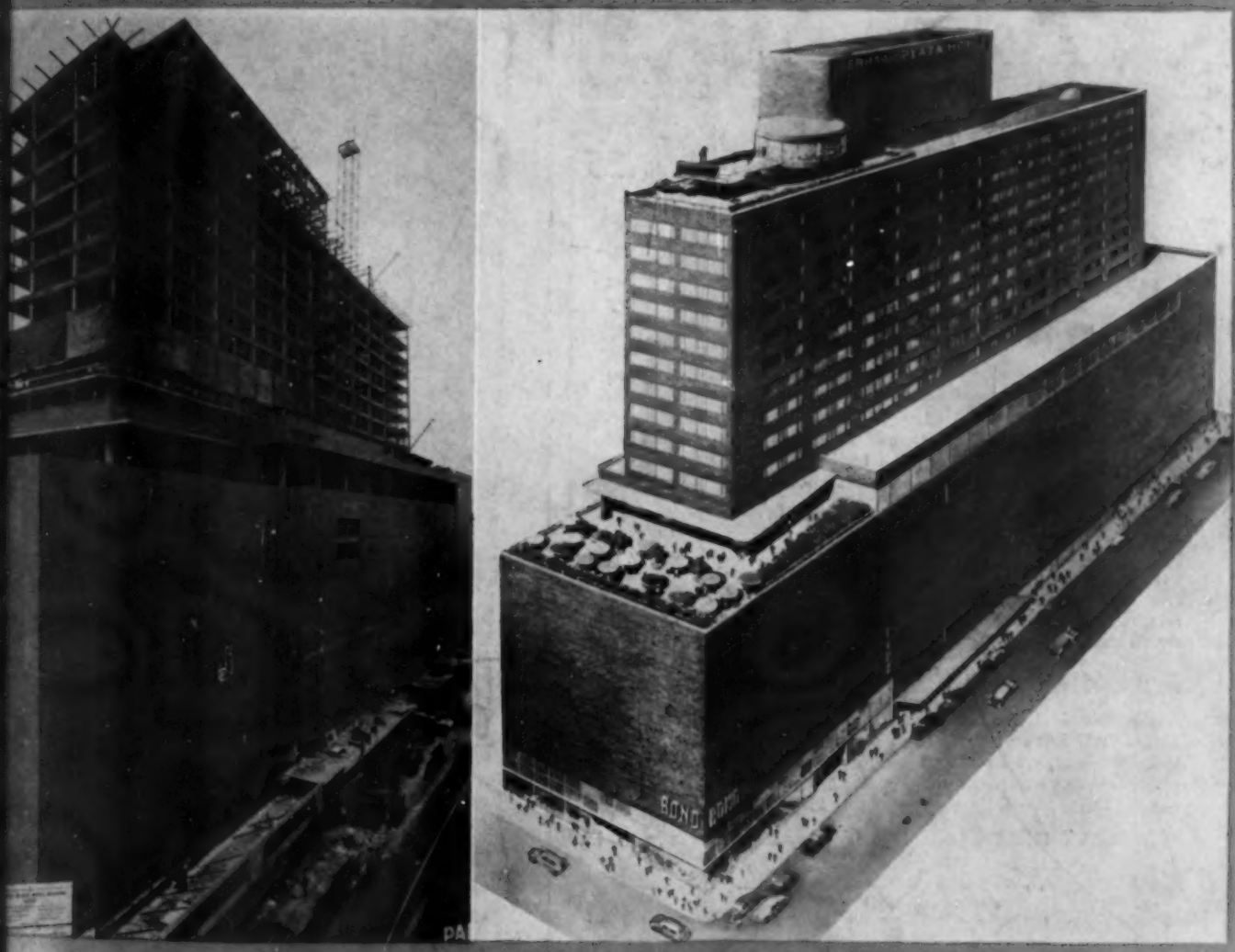
107—Journal Section of the American Society of Heating and Ventilating Engineers



Air conditioning of the unusual Terrace Plaza project —a hotel on top of a store building— is described this month (page 71)

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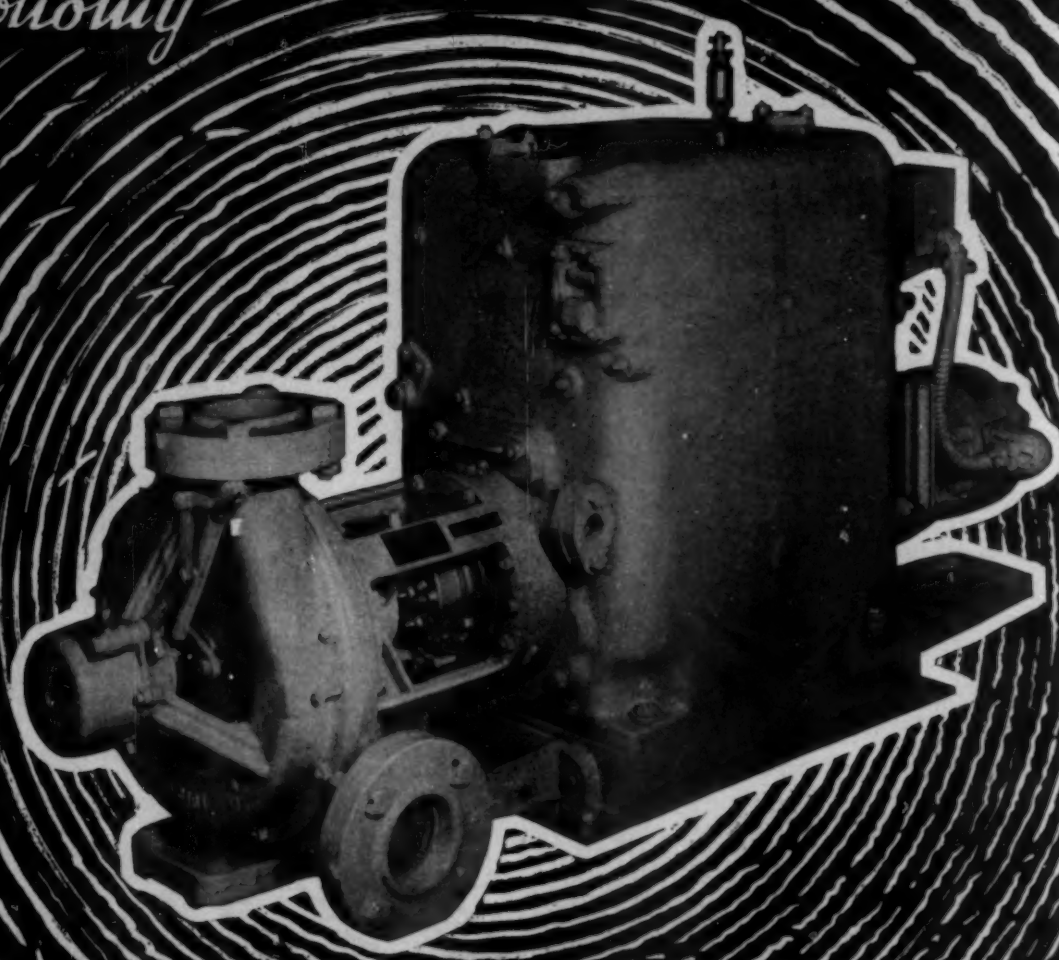
Centralized Heating Economy



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This view of the exterior of the hotel (photo taken from eighth floor setback) shows the air risers in the centers of the bays

Air Conditioning a Vital Part of Architectural Design

H. C. Hoffmann, Project Manager, Carrier Corp., Analyzes Requirements of Cincinnati's Terrace Plaza Hotel Building

AN OUTSTANDING example of postwar construction—both architecturally and mechanically—is the Terrace Plaza hotel building, now under construction in Cincinnati for Thomas Emery's Sons, Inc., of that city. It typifies the complexity of present-day building, which makes imperative close coordination between engineer and architect—a sharp contrast to the frequent and unfortunate architectural practice not so many years past of design with little or no consideration for the problems of the mechanical engineer. The variety and extent of mechanical equipment—particularly air conditioning and refrigeration—required in present-day construction have made its consideration a vital part of overall good architectural design.

Hotel on Top of Store

From an architectural standpoint, the basic conception and design of this building are unique, since the building is a combination of hotel and department store—with the hotel unit, 10 stories in height, located on a seven story department store monolithic base [see illustrations on front cover.] This combination was the direct result of an intensive study made by the architects and the owners to determine the type of building best suited to the site and which would provide the greatest return on the initial investment. A combination office and department store building was considered but rejected when a 2 per cent greater return was indicated by the choice of the hotel-department store arrangement. The location of the hotel, with its main lobby on the eighth floor, is a clear defiance of traditional hotel design, but is a practical solution since the department stores obviously required the ground level location.

The two main units of the building, while coordinated in design, were each studied as separate problems and treated to serve efficiently the purposes intended. For example, in the lower section of the building, to be occupied in the main by Bond Stores, Inc., and J. C. Penney Co., it was recognized that windows above the first floor would have no purpose since the value of the light received from windows would be negligible—even detrimental—and the windows would serve only as backdrops for store fixtures. As a result, the facades of this building are windowless and thus present a striking appearance of simplicity, broken only by the outside air intakes located on the long side of the building. This functional windowless construction was made possible only through the use of improved modern lighting techniques combined with the applica-

A HOTEL AND DEPARTMENT store—with the 10 story hotel unit on top of a seven story department store base—is the unique scheme for the Terrace Plaza project under construction in Cincinnati. A complete discussion of air conditioning requirements and how they are being met is given here by Mr. Hoffmann, who is in charge of all air conditioning, refrigeration, and ventilation for the structure. Many ideas for postwar construction are included

tion of comfort air conditioning.

The hotel unit, on the other hand, was treated in the opposite manner. Here the view and natural light are important, both in the public spaces and in the private guestrooms, and hence in this portion of the building the maximum use of glass was made. Each hotel room has a "picture" window 10 ft wide to afford maximum light and view. In the eighth floor public space sections, almost continuous glass is used, and the climax is reached in the circular penthouse restaurant, the walls of which are constructed entirely of glass.

The blank wall of the lower department store unit has been given architectural interest by the use of Norman size brick (oversize 12 x 4 x 2 in.) with all joints aligned vertically, thus resulting in an unusual effect. Each fifth course is of special brick, approximately twice as large as the standard brick, thus furnishing a header course and at the same time making the finish appearance identical with all other courses.

Maximum use of glass is also evident in the treatment of the first floor of Bond, which is an example of the modern open store front design used to stimulate interest on the part of passersby and thus increase sales. This area has a two story show window, as well as an unusual lighting system which in effect serves this sales floor with one light, thus creating maximum uniformity of lighting with absence of shadows.

Here is a typical hotel floor showing air and water risers for the air conditioning system

An unusual feature of the building is the open air terrace dining space provided by the roof setback of the department store. It is from this terrace that the building takes its name. This area also serves as an open air skating rink during all seasons of the year when the weather is such that outdoor dining is not feasible.

The block upon block design of the entire building ends in the block containing the penthouse kitchen, exhaust fans, and elevator machinery—together with the masonry enclosure of the cooling tower which serves the air conditioning system. This tower is thus not visible in elevation and the unsatisfactory appearance which often results from the use of exposed cooling towers is avoided.

Air Conditioning Design Problems

This building offers a great diversity of space uses, primarily because of the combination of hotel and department store. These uses range from the cafeteria in the sub-basement through the department stores and beauty parlors, small shops (including barber, jewelry, shoe, and drug stores on the first floor and in the basement), lobbies and arcades, eighth floor cocktail lounge, lobby and hotel dining rooms, to the hotel guestrooms and Gourmet restaurant and kitchen in the penthouse.

Combinations of spaces on a common air conditioning system therefore had to be made with study and care if satisfactory operation was to result. Combinations, however, were a paramount necessity in order to reduce to a minimum the valuable floor space occupied by the air conditioning apparatuses. Vital in the study of this grouping was the time element of length of operation, which varies from approximately 8 hr for the department stores to 24 hr for the hotel guestroom system.

In addition to the air conditioning systems, a great variety of ventilation service is necessary, including such spaces as kitchen areas in the sub-basement, eighth floor and penthouse, truck loading area in sub-basement, and toilet exhausts throughout the building. Likewise the usual problem of disposal of exhausts bearing odors to avoid short-circuiting to nearby air intakes required solution.

Threaded through these design problems, however, was the fortunate condition that the entire building is to be maintained by one staff representing the owner. This fact made it possible to centralize and concentrate the total refrigeration required for the air conditioning systems, thus simplifying this phase of design.

Air Handling Apparatuses

With the exception of the small air conditioning unit in the penthouse, grouping and concentration of equipment resulted in a total of five air conditioning fan rooms located one each in the sub-basement, second floor, sixth floor, seventh floor, and eighth floor. Miscellaneous exhaust fans are located generally close to the areas served, or in the penthouse, and not in the air conditioning apparatus rooms.

From the standpoint of air flow to and from the building, air intakes for the most part are on the north wall with general exhaust systems discharging on the south wall, and odor exhausts (such as kitchen and bathroom exhausts) at the extreme top of the building. As a result, it is felt that an irreducible minimum of shortcircuiting will occur regardless of wind direction.

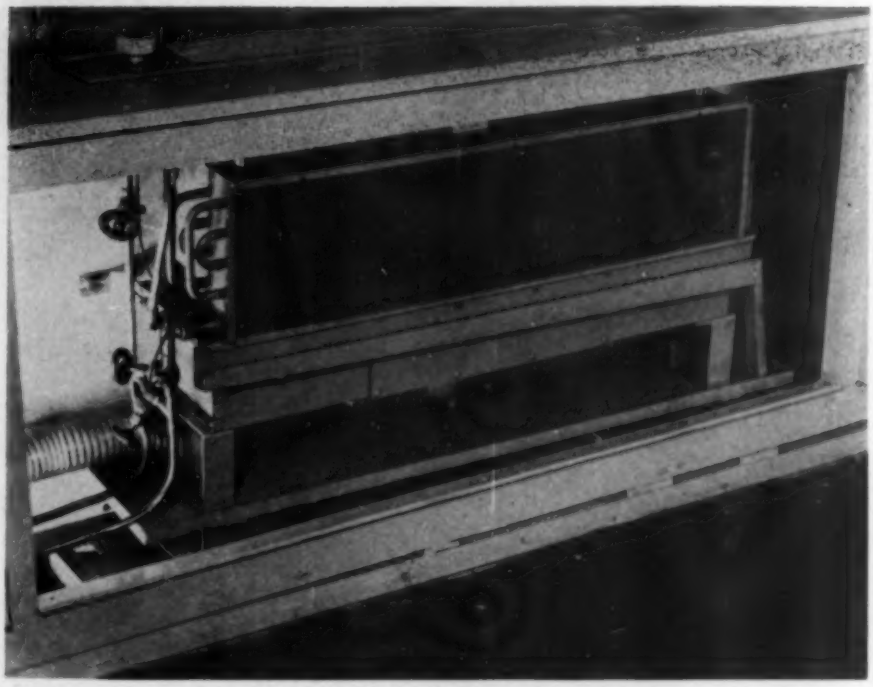
Generaly described, the air handling apparatuses consist of 99 separate fans ranging in capacity from 350 to 49,000 cfm, and driven by motors ranging in size from ¼ to 30 hp. The total connected fan

horsepower load is approximately 500 and results in a total air circulation of approximately 1,200,000 cfm.

The air conditioning systems serving the stores and main hotel areas are conventional builtup apparatuses which include steam preheaters and reheaters, filters, spray coil dehumidifiers, centrifugal type supply and return fans, and face and bypass damper control. They are of especial interest, however, on two different counts.

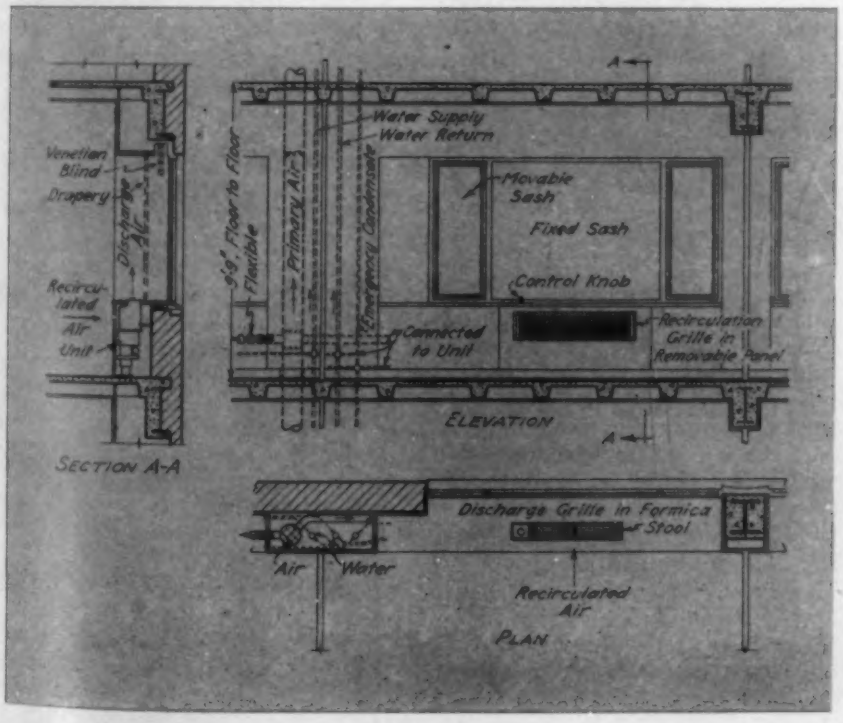
The first of these is the widespread use of electrostatic filtering, one of the largest single installations of this filter medium for comfort air conditioning purposes. The use of electrostatic filtering is justified by the optimum air cleanliness which will result, thus reducing soiled merchandise in the store areas and decorating maintenance costs throughout the entire building.

The second feature of the air conditioning systems resulted directly from the use of this type of filtering and the requirement that all air be filtered at all times. To meet this requirement and use face and bypass damper control properly, the normal practice is to employ filters in the bypass ductwork—which results in a total filter area for any one apparatus in excess of total air volume supply requirements. This condition obtains because of the variation in flow resulting from the use of bypass control and the need for sufficient filter area for peak flow through both the coil and the bypass. Due to the relatively high cost of electrostatic filters, and in order to keep this cost to a minimum, a variation in apparatus layout was employed so that one portion of the filter serves a dual purpose. By means of an auxiliary return air damper, this section acts as either a return air filter or an outside air filter, depending upon the season of the year and the amount of outside air that is taken for ventilation. In this way, approximately 25 per cent extra filter area is saved and without sacrifice of humidity control, since return air only can be bypassed under this arrangement.



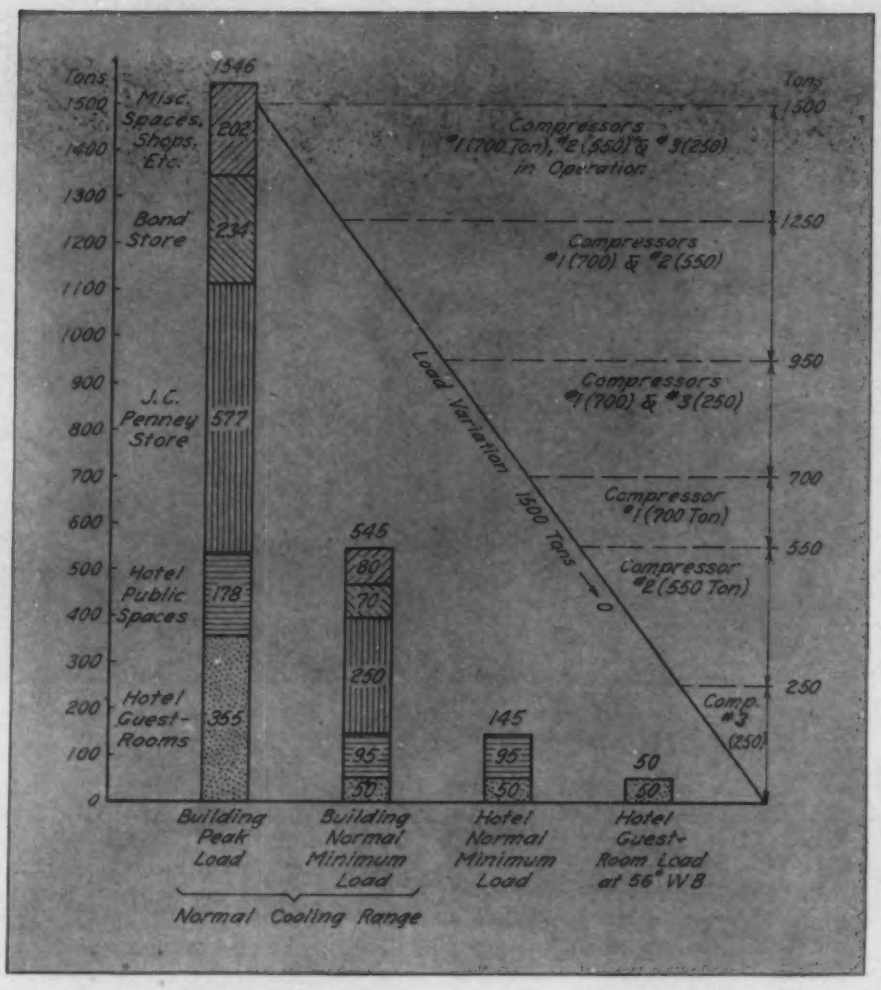
Mockup enclosure for a typical air conditioning unit, 440 of which are used in the hotel guestrooms; they are built into the window stools

The guestroom window units have removable front panels for accessibility, with removable sections on each side for complete access to all piping



With respect to the systems serving the store areas, positive removal of air was imperative due to the vault type of construction with the absence of openings for exfiltration. This has been accomplished by the use of return air fans with dampers in the ductwork between the discharge of the return air fan and the intake of the supply apparatus, these dampers serving to spill air to the apparatus room as an exhaust plenum. This plenum is in turn exhausted by a multiple installation of propeller type fans located in the south wall. Due to the variable outside air requirements, this spill and exhaust are likewise variable and accomplished by positioning of dampers in conjunction with the cutting on or off of the spill exhaust fans. This method of positive air removal is coordinated with the various toilet and other exhausts from the air conditioned areas to assure a positive supply of outside air for proper ventilation of these spaces.

In order to group certain areas with respect to the air conditioning apparatuses, it was necessary to employ reheat control in a few instances. This was considered an



This chart shows the refrigeration requirements and air conditioning load breakdown for the Terrace Plaza hotel building

economical solution due to the lesser floor area required by this method compared to separate apparatuses and because steam is available at all times—since it must be generated in the summer for use in the various kitchens. An example of a reheat system is the apparatus serving the small shops and arcades in the center of the building located in the basement and first floor and involving a total of eight distinctly separate spaces. For the most part, however, face and bypass controls are used with reheat in sequence to prevent overcooling at light loads and maintain satisfactory humidity at this condition.

Hotel Guestroom System

The 400 hotel guestrooms are air conditioned by means of 440 window units which are built in to the guestroom window stools and have removable front panels for accessibility. Additional removable sections on each side of these panels are provided for complete access to all branch air and water piping. This design is an excellent example of the coordination between the architect and the engineer which is typical of the entire building.

The primary apparatus for these rooms is located on the seventh floor and serves to filter, and to humidify or dehumidify (according to season), the outside air which serves the guestroom units. This outside air is fed to the units through distributing headers which run in the ceiling of the main hotel areas on the eighth floor and which connect to vertical conduit risers located one each in the middle of each bay. This outside air is fed to the guestrooms in constant quantity at all times and is in turn a source of exhaust for the individual bathrooms, thereby isolating each guestroom and making impossible the transmission of odors from one room to another.

The outside air enters the units through nozzles at a velocity of approximately 4000 fpm and thus creates an induced flow of air from the room in a ratio of three volumes to one. This recirculated air passes over the unit water coil. Return ductwork is not required since return air is not used.

The circulating pumps that furnish cold or warm water (depending on the season) to the window units are located in the seventh floor apparatus room also and feed through the eighth floor ceiling to vertical risers with the returns collected in the 18th floor ceiling space. Individual control of space temperatures in the various guestrooms is provided year 'round by the modulation of these water temperatures and by the control of the flow through the individual guestroom unit coils to accomplish maximum flexibility of space temperature at the command of the room occupant.

The hotel corridors are cooled and ventilated by a separate system of supply and exhaust to prevent further the interchange of air between the guestrooms and also to eliminate the stagnant condition that would exist in the corridors without such ventilation.

By means of this conduit air conditioning system with its system of vertical distribution, all horizontal ducts are eliminated from the guestroom floors thus permitting 9 ft, 9 in. floor to floor dimensions. Inasmuch as the overall height of this building was limited by zoning ordinances, this made it possible to build 10 floors of guestrooms, which would not have been possible if horizontal distribution had been employed.

Refrigeration for Air Conditioning

Load calculation studies indicated a total capacity requirement for refrigeration of approximately 1500 tons. Roughly, this 1500 tons consists of 1000 tons for the lower block involving the department stores, and 500 tons for the hotel proper.

The diversity of space uses indicated the need of wide range capacity variation—from the extremely light load of the hotel guestroom system at night and in late fall and early spring to the peak total load of 1500 tons.

To meet this need, three centrifugal refrigeration machines are used with capacities of 250, 550, and 700 tons. These machines use Carrene No. 2 as a refrigerant and are driven by wound rotor motors of 250, 600, and 700 hp respectively, each controlled by a starter with five balanced points of speed variation. All three machines are interconnected in a main chilled water piping loop in the sub-basement refrigeration room. The combination of the vari-

able speed motors and the ability to cut machines of different capacities in and out of service provides extreme flexibility to meet the increments of load from minimum to maximum.

The multiple refrigeration machine installation also affords a measure of standby protection as compared to a single unit, which is important particularly to the systems serving the windowless portion of the building. A shutdown would be highly unsatisfactory in these areas because the heat from lights and people, with ventilation only, would result in uncomfortable conditions in a very short time.

The main chilled water loop is served by two 25 hp pumps with standby, thus furnishing flexibility in flow for this loop. The hotel systems are fed by one 25 hp pump and the store systems by two 25 hp pumps, which draw upon and discharge back to this loop as a source of chilled water. The pumps for the hotel and stores are so arranged that the water quantities and approximate head requirements are the same so that it was possible to cross-connect an additional 25 hp pump which serves as a standby common to both systems. The breakdown in chilled water flow is 1600 gpm to the stores and 800 gpm to the hotel, thus making the total of 2400 gpm which can be cooled by the centrifugal machines from 57 F to 42 F for design peak.

The separate pumping and chilled water circuits provided by this arrangement permit independent or joint operation of the hotel and stores systems as required to meet the difference in usage between these systems. With the use of face and bypass control at the air conditioning units, the decision was made to eliminate three-way valves, except in rare instances, thus stabilizing the chilled water flow at all times once the various coils are balanced to obtain the flow required for peak load. Variations in main chilled water loop temperature will be made in accordance with a schedule of outside wet bulb temperatures and will be regulated from the engineer's office in the sub-basement.

Condensing water is furnished by two 2250 gpm pumps which provide a total of 4500 gpm of water cooled by an induced draft twin tower of all steel construction from 95 F to 85 F with 78 F wet bulb prevailing. A standby pump is also furnished for condenser water service.

A fire protection system of very recent design is used for the open escalators in the Penney store. It preserves the sales advantages of store escalators.

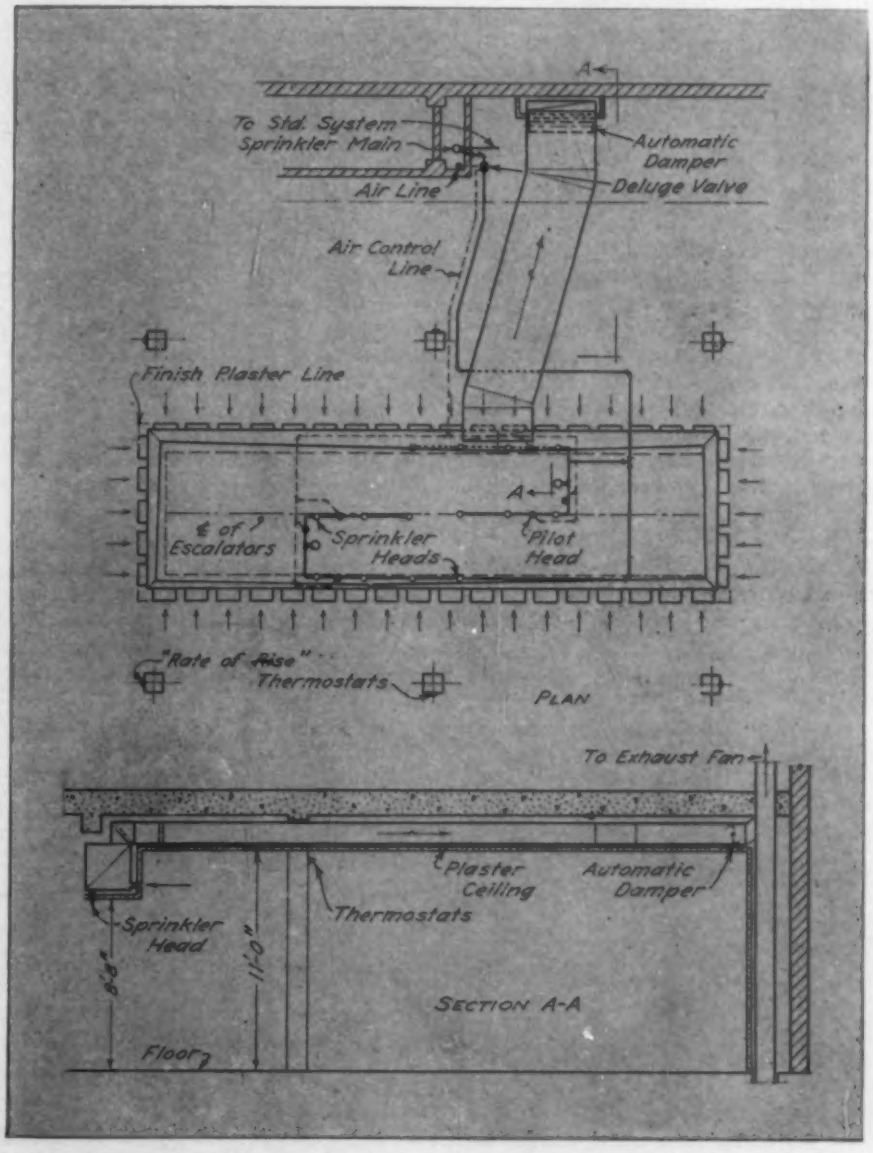
Modern Lighting Creates Special Problem

The use of modern lighting techniques with high wattage is general throughout the store areas and reaches a climax in the treatment of the Bond first floor area.

The main lighting for this sales floor consists of fluorescent tubes totaling approximately 8800 lineal feet located in the space between the hidden plaster ceiling and the exposed ceiling of translucent glass construction. The result is that the sales floor receives its light, in effect, from one large fixture, 67 ft wide by 90 ft long, involving a total electrical load of approximately 50,000 watts.

In accomplishing this unusual lighting effect, special treatment was necessary inasmuch as the heat from the tubes is trapped in the ceiling space bounded by the plaster and the translucent glass. To accomplish this, the air conditioning supply ducts and a system of exhaust were installed above the plaster ceiling with the exhaust connected to the space in which the lighting tubes are located. The air conditioning supply duct, by means of drop collars and pan type outlets, supplies approximately 5000 cfm of cool air to this lighting area which the system of exhaust removes to the outdoors. To serve the occupied area, additional supply collars run through the lighting space and connect to square type ceiling diffusers sized to furnish the required amount of air and also fit the pattern of the glass ceiling. The fan serving to exhaust from this lighting tube area is also connected to the nine ballast cabinets which are required for this fluorescent lighting and thus these cabinets are ventilated as needed to remove the heat generated by this ballast.

By means of this special treatment, the ambient temperature at the fluorescent tubes is kept at ap-



proximately 85 F, which will result in long tube life. In addition, the main heat of the ceiling lights is removed at the source instead of being permitted to travel to the room which would in turn require considerably greater air volumes in the occupied area.

While the light loads for most of the store areas average 4 to 5 watts per sq ft, which is higher than for most similar sales areas, this first floor area of Bond's store is a clear case of the absolute need for air conditioning with modern lighting. Since this space is also served by the two story window area, with open type show windows, the show window lighting is a part of the room load. In other words, by this new approach to show window treatment, it is not possible to calculate transmission only through show window partitions as is generally true of most department stores. The net result is a lighting load of 15 watts per sq ft of sales floor and a total refrigeration requirement of 0.0093 tons per sq ft for this floor—vastly different from the 0.0030 to 0.0040 tons per sq ft of a few years ago.

Escalator Fire Protection System

In the stores of this building, the normal systems of fire protection and control, incorporating sprinklers and every means known to science to accomplish maximum protection, have been employed. Included among these methods are electronic eyes for smoke detection in return air and outside air duct systems, high temperature thermostats in return air ducts, and flow valves in the sprinkler system piping. Anyone of these controls, when actuated, will shut down the supply fans serving the areas in which the abnormal condition exists. All of these standard controls are connected to a panel in the engineer's office to acquaint him immediately with the situation.

In addition to these systems, a fire protection system of very recent design is to be installed for the open escalators in the J. C. Penney Co. store. To understand the need for this system, the purpose and past treatment of escalator systems must be understood.

The twofold purpose of escalators in department stores is to facilitate transportation of customers from floor to floor, and to accomplish sales benefits as a result of the elevated view of the sales floor obtained by the customer while riding on the escalator. Due to the large openings required from floor to floor, a fire hazard is presented. This hazard has been recognized in many city ordinances which make it mandatory to close off escalators by partitions, thus removing the sales benefit feature upon which the cost of escalator installations is frequently justified.

While new, the modern approach to this problem in the J. C. Penney Co. department store has been thoroughly tested and has already received acceptance by inclusion in a number of city codes, including Cincinnati's. Briefly described, this system consists of the following:

1) An exhaust ring of heavy gage welded black iron, with collar intake openings on the outside of the ring, is located around the escalator on each floor and is connected by branch ducts to a riser which in turn is run to an exhaust fan on an upper floor.

2) At the connection of the branch duct to the riser, there is an automatic damper in the branch.

3) "Rate of rise" thermostats are mounted just below the ceiling at the columns surrounding the escalator and on scattered columns in the adjoining bays.

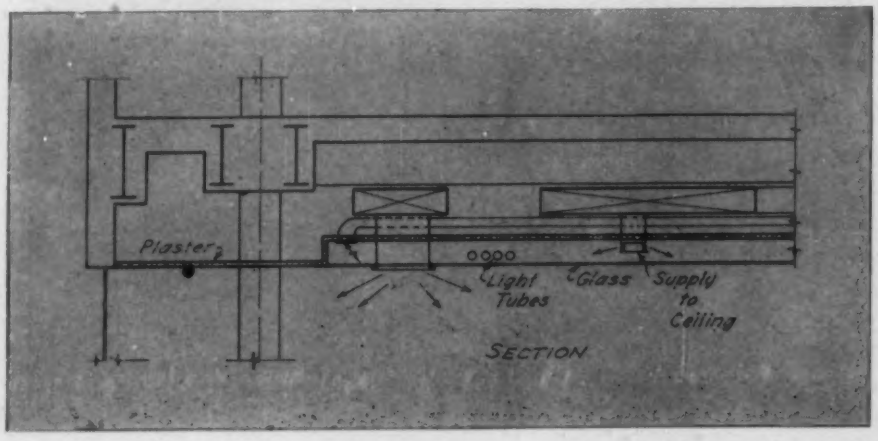
4) An auxiliary outside air intake is located in an outside wall on the top floor and provided with automatic dampers.

5) Special sprinkler heads are located around each escalator between the escalator proper and the exhaust air ring. This sprinkler system is furnished with pilot heads and is in addition to the standard sprinkler heads.

If a fire occurs and the temperature rise exceeds the rate of rise setting of the thermostats, these thermostats (by means of pneumatic and electric control) operate to open the auxiliary outside air damper and the branch damper for the floor on which the fire exists and also start the exhaust fan on the upper floor. The outside air enters the building through the auxiliary intake, passes down the escalator openings to the floor on which the thermostat and the fire are located and where the entire capacity of the fan is being exhausted. This exhaust creates a negative pressure on this floor to exhaust the smoke and prevent its flow to any other floor. Through an alarm bell and annunciator system in the engineer's office, the fire condition and its location are transmitted to his attention in order that action may be taken.

If the fire spreads to the escalators proper, the sprinkler pilot heads release to set off a water curtain surrounding the escalator. In this manner, smoke and fire are isolated in spite of the comparatively large floor to floor openings, an exhaust is created to remove the smoke, and the sales benefits of the escalator system are retained.

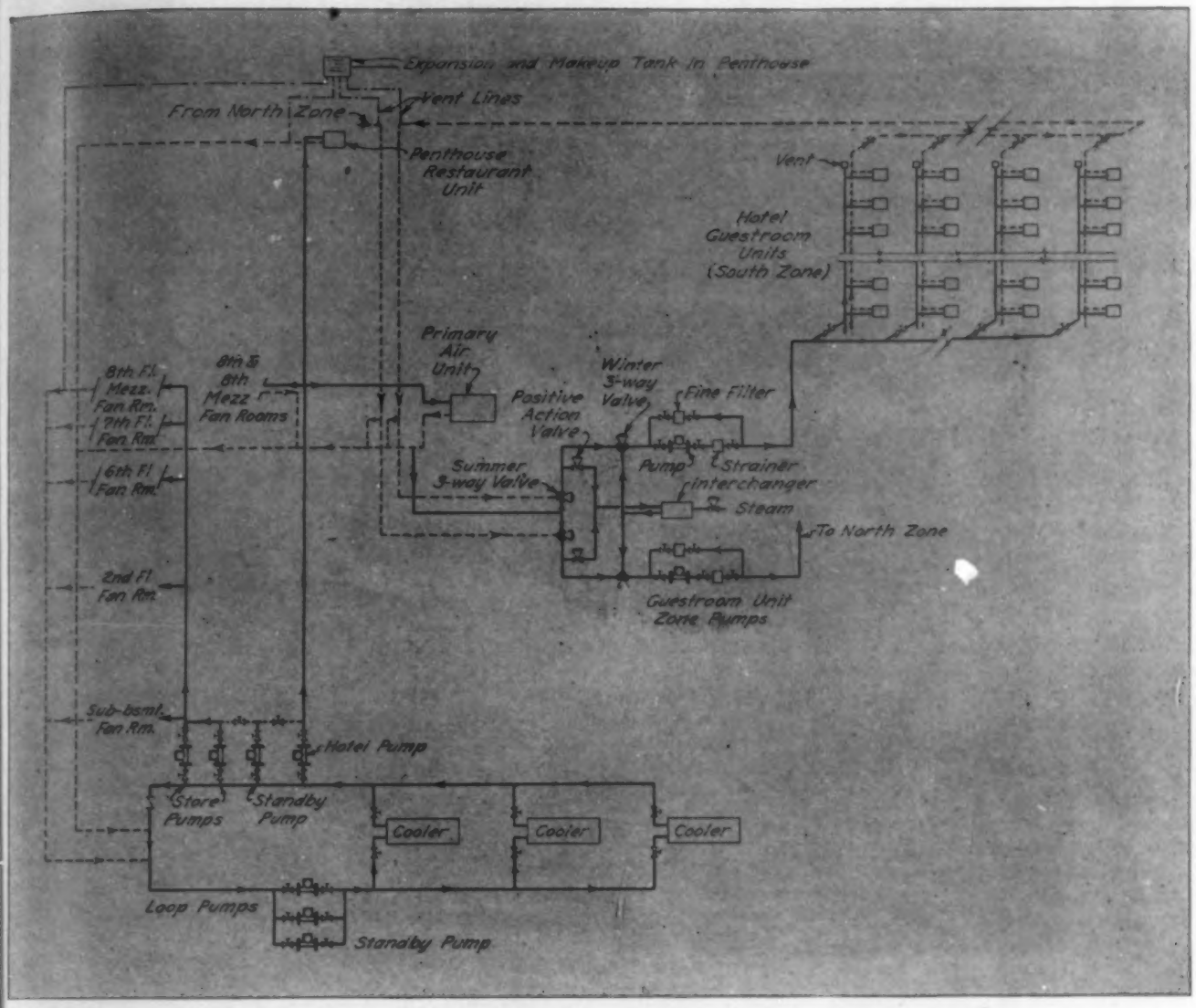
Ambient temperature at the fluorescent tubes is kept at approximately 85 F by means of air supply and exhaust for the space between the plaster and glass where the lighting tubes are installed



Commercial Refrigeration

Due to the combination of kitchens on three levels, and cocktail bars on two levels, together with extensive drinking water refrigeration systems, a considerable amount of commercial refrigeration was required. As opposed to the brine circulating systems formerly used, the more modern approach of direct expansion has been followed with compressors grouped for maximum efficiency in the vicinity of the boxes and spaces to be refrigerated.

There are 45 different refrigerated spaces, ranging from a 3 cu ft reachin box to a 910 cu ft wine room, the latter being located in the penthouse to chill wines for the patrons of the Gourmet restaurant. Twenty "Freon" condensing units serve this commercial refrigeration duty.



The separate pumping and chilled water circuits permit independent or joint operation of the hotel and stores systems as required to meet the difference in usage

When the further complications are added of a skating rink on the eighth floor terrace, window heating for the two story first floor window of Bond, panel heating for the Gourmet penthouse restaurant, and a multitude of other space temperature control problems, it can be seen that this building is an outstanding example of the tremendous part that air conditioning and refrigeration play in modern building design. Likewise, it is evident that extremely close cooperation between engineer and architect must be the rule in order to insure satisfactory performance.

Increased Importance of Air Conditioning

It is reasonable to expect that the role of the air conditioning and refrigeration engineer will grow rather than diminish as the requirements of modern buildings for space temperature control increase. It seems clear that postwar construction, as exemplified by the Terrace Plaza hotel building, has ushered in an era in which the profession will assume increasing importance in the field of building design and construction.

The Terrace Plaza hotel building was designed by the architectural firm of Skidmore, Owings and Merrill of New York City, with Jaros, Baum and Bolles, New York City, as consulting engineers for air conditioning and refrigeration. The general contractor is Frank Messer & Sons, Inc., Cincinnati. Air conditioning and refrigeration equipment is being installed by Carrier Corp.

NEW YORK UNIVERSITY OFFERS EVENING WORK

A broad program of courses in building construction, air conditioning, and heating will be offered during the coming fall term by the division of general education of New York University, Washington Sq., New York 3, N. Y. They will be given in the evening and are intended primarily for men in the field; there are no formal prerequisites for admission.

Among the subjects are construction plan reading and estimating; building codes and contracts; basic heating and ventilating; air conditioning; air conditioning design; elements of refrigeration; and plumbing theory and codes. These courses are supplemented by a basic program in mathematics, physics, and technical drawing for those not prepared for advanced work.

Kalman Steiner Reviews Tight Coal, Oil and Gas Situations, Gives Suggestions for Reducing Fuel Consumption

FUEL FORECAST

. . and What To Do About It

NEWS REPORTS forebode a fuel scarcity for the coming winter. Limited supply, transportation difficulties, and unprecedented demand may combine to create as tight a fuel situation as existed at the peak of wartime exigency.

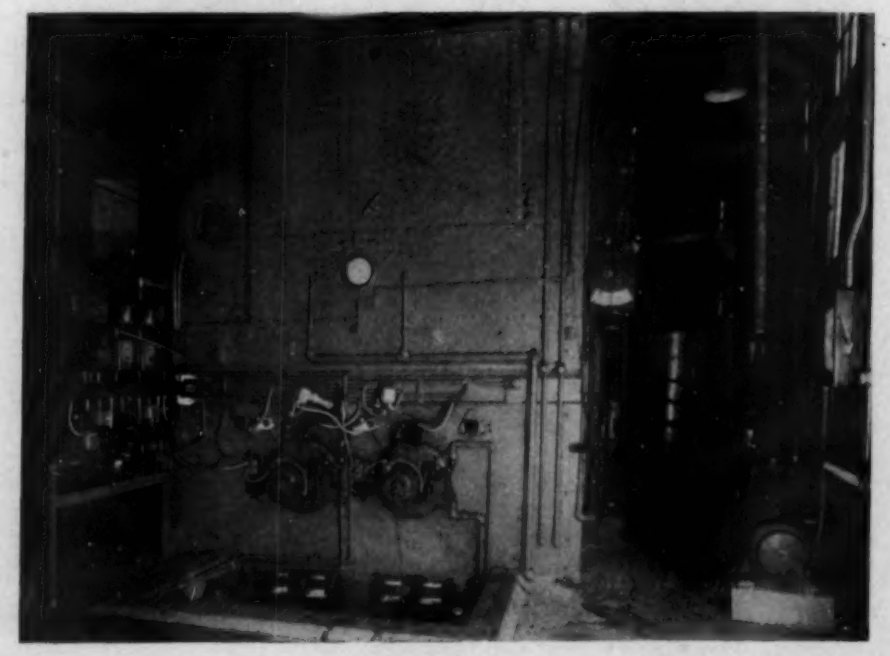
Fuel users should review carefully the factors that affect their fuel requirements and utilization for the next 12 months. Common prudence dictates that analysis be made of the circumstances governing the supply, and of the steps that can and should be taken to conserve it —and that preparation be made for attaining a flexible condition in plant and building operation from the viewpoint of fuel utilization. Here is a brief summary of the fuel situation, based upon latest available data from the Bureau of Mines and other authorities.

Bituminous and Anthracite

For the first seven months of 1947, production of bituminous coal (including lignite) was somewhat ahead of the same period for 1946, but last year production had fallen considerably below 1945. The figures for tonnage in each year are: 1945 —329,807,000; 1946—280,041,000; 1947 —343,028,000—in each case through July. Comparable export figures are not yet available, but it is well known that we send a great deal of coal abroad. During 1945 we exported 28 million tons. For the same year our own consumption totaled almost 560 million tons, making a grand total of 588 million tons used or exported. Yet, for that year we mined only 577.6 million tons—meaning we must have drawn heavily on stockpiles, since our imports of coal are negligible. Hence it cannot be expected that bituminous coal will be plentiful during the coming winter.

The picture for anthracite is much worse. For the first seven months this year production was off 7.2 per cent from last year—the country mined 30,380,620 tons through August 2, a decrease from the same period last year of 2,374,028 tons. Of total anthracite shipments from the mines, steam sizes (buckwheat and smaller) constitute about 40 per cent.

Plants having more than one boiler should consider the possibility of equipping one for burning coal, the other for burning oil. A bit of planning now may pay dividends this winter



Petroleum and Fuel Oil

The petroleum and fuel oil situations seem to offer baffling aspects to many persons, and yet it has repeatedly been stated by authorities that there is no shortage in supply of crude oil or refined products but that there does exist a temporary shortage in transportation facilities —particularly in the north central states—and the contemporary tight steel supply does not offer quick relief in the form of new tank cars

and new long-distance pipe lines.

According to the Bureau of Mines, the total demand for all petroleum products averaged 5.87 million barrels daily for the first four months of 1947 compared with 5.25 million for the same period in 1946—an increase of almost 12 per cent. If the potential demand for the remainder of the year is to be met, refinery capacity and transportation facilities must be operated at maximum levels. Crude runs to stills reached a record level of 5 million barrels daily in July 1945. Actual runs in the first quarter of 1947 averaged 4.8 million and probably have approximated 4.9 million in the second quarter. The difference between demand and refinery runs represents imports and transfers from crude stocks as residual fuel oil.

The percentage yield of residual fuel oil from refined petroleum in 1946 was about 24.9, off 2.3 from 1945. The highest percentage yield recorded was 29.2 in 1943; over the past 15 years it has varied between that high and a low of 24.3 (1940). During 1946, production and imports of residual fuel oil exceeded demand and export by more than 11 million barrels.

Natural and Manufactured Gas

Data on natural gas production for 1946 and 1947 are not yet available. Latest figures, for 1945, show steadily increasing use of that valuable fuel. Production in 1945, totaling 3,918,686 million cu ft, exceeded 1944 by almost 6 per cent, which latter year itself had exceeded 1943 by close to 9 per cent. In fact, each year the amount of natural gas used has shown an increase. This pyramiding apparently has brought a not unexpected result—the ultimate capacity of existing transportation facilities (pipe lines) has been reached. In many localities, gas utilities are declining to accept new customers, and are limiting the amount that may be used by some classes of existing customers.

The number of commercial consumers of natural gas during 1945 increased 5 per cent to a total of 889,000, of which 755,000 used 100 per cent natural gas while the remainder used a mixture of natural and manufactured gas. Of the total production of 3,918,686 million cu ft of natural gas, commercial users burned 6 per cent. The remainder was distributed as follows: domestic, 15; oil and gas fields, 24; carbon black, 11; petroleum refining, 9; central station generating plants, 8; and miscellaneous, 27 per cent.

COULD BE that the fuel situation this winter will be as tight as at anytime during the war, judging from predictions of various authorities. While fuel economy is a perennial subject (like housecleaning) it offers about the only way the individual plant or building can beat restricted fuel supplies. Kalman Steiner—member of HPAC's board of consulting and contributing editors, author of several books on fuels and their firing—who is with C. Hoffberger Co., gives practical suggestions for saving fuel, advises planning now for flexibility in changing from one fuel to another

Fuel economy is a perennial subject. It comes up for annual discussion, somewhat like housecleaning. When its pressing and critical need is made manifest, when its crucial importance is stressed, and when its urgency is importuned, then everyone embarks upon a flurry of activity, seeking every stray Btu that can be impounded. This feverish zeal usually lasts a week, sometimes as long as a month. Then gradually, under the pressure of more immediate problems of production, everyday operation and other routine affairs, it becomes more and more an academic topic, honored far more in the breach than in the observance.

Perhaps the chief difficulty in achieving genuine fuel economy is that the subject is tacitly assumed to be the concern of only one person —generally the plant or building engineer—whereas actually it should be everyone's concern. It is commonplace to see signs hung around a building requesting that electric lights be snapped off when not needed. Why not similar reminders for heat conservation?

Fuel Saving Should Be Everyone's Concern

All occupants of a building ought to be equally conscious that windows are not to be opened when there's steam in the radiators. Shippingroom employees are sometimes prone to forget open doors even when heated air is being poured into the space. Persons working overtime push thermostats to daytime temperatures, neglecting to restore them to night settings when leaving. Heat leaks like these cannot be spotted by a busy engineer. Perhaps a plant or building committee would be more effective in detecting such violations of fuel economy. And maybe the suggestion box, with suitable awards for appropriate suggestions, could be used to good advantage in stimulating interest in a "save fuel" campaign.

The lessons learned in wartime can be used to good advantage during the coming winter. Fuel records for a given plant or building will reveal at what rate fuel should be used per degree day (or per some other unit). A fuel budget should then be set up, and the current consumption compared to previous experience to observe whether the campaign is accomplishing results. A self-imposed rationing system may have to be adopted. One way or another, the sensible thing is to reduce fuel consumption below the normal.

Fuel Economy Signifies Good Operation

In the boiler room, fuel saving may become so trite a topic as to become commonplace — and, ultimately, unmeaningful. Were it recognized that fuel saving can signify good operation in many diverse ways, or vice versa, it would add zest and interest to the appeal.

One plant was experiencing much trouble with the melting of grate bars or tuyeres on an overfeed stoker. The chief engineer tried various coals, and seemed to think that because an occasional load of coal appeared to be less injurious than others, he would have to seek until he found some special coal suited to his peculiar furnace conditions. Not long after, the refractory also began to disintegrate, and he was compelled to call in outside help.

A hasty survey of conditions revealed that as his load had increased somewhat, so had the combustion rate. As a consequence, furnace temperatures were running high. Under his horizontal tubular boiler, the bridgewall was quite high; it had not caused trouble at low combustion rates but with higher heat release it acted as a baffle, preventing reflection of radiant heat into the under shell of the boiler. Furthermore, the fireman had been carrying thick fuel beds, and in attempting to hold steam pressure had shaken clinker frequently, bringing glowing embers into direct contact with the grate bars.

The combustion experts straightened this plant out in a hurry—lowered the bridgewall, instructed the fireman to carry a thin fuel bed with a protective layer of ash on the grates, and instituted a procedure for manual setting of the damper with load changes. Within a few weeks the chief was able to report that his grate bars were holding up well and that—unexpectedly—his fuel consumption had dropped.

Investigate Rapid Refractory Decay

Rapid refractory decay should always be investigated from the viewpoint of improper operation, as well as from the possibility of poor quality or bad installation of refractory. The trouble may be due to low settings, short fireboxes, high bridgewall, improper air distribution, or a number of other factors that govern combustion phenomena. It is almost a truism that any remedial steps taken to lengthen refractory service will almost invariably be accompanied by improvement in fuel economy.

Baffles constitute another threat to efficiency; their breakdown allows shortcircuiting of combustion gases and consequent high stack temperatures. Dry-back scotch marine boilers have a potential weak spot in the rear combustion chamber arch, because any cracks or other openings there permit entrance of air to cool the combustion gases. The same is true of the rear arch of a horizontal return tubular boiler.

Restrict Air Flow Through Setting

Much has been written about draft control, excess air, and the fuel waste that ensues when combustion regulation is slighted or overlooked. Perhaps one thought that has not been stressed sufficiently is that of restricting air flow through the boiler setting during the burner off cycle (i.e., when coal stoker, oil burner, or gas burner is shut off by the steam pressure limit switch), which can occur with some frequency during periods of light or moderate load. Where automatic controls cause intermittent starting and stopping, combined with modulation of firing rate, the fuel feed and air ports are usually at minimum before the complete shutoff occurs, but even this reduced air port setting will permit some air flow through the firebox and boiler tubes.

Fuel saving can signify good operation in many diverse ways, and vice versa

It is possible (and modern systems usually include this feature) to incorporate some method of closing the uptake damper almost completely, or of swinging open a large check damper attached to the breeching, in order to minimize this loss of heat from cooling of the idle boiler and setting. But when it is used, this feature must also provide some means of locking out the fuel feed until the draft has been reestablished when the control system again calls for steam.

Clean Tubes Aid Fuel Economy

Tube cleaning is possibly the next most important contributor to fuel economy. Most operating men form the habit of performing it at certain intervals—perhaps weekly, or if the plant has but one boiler, at less frequent intervals. Too often, the signal that tubes need cleaning is the inability to hold up steam pressure. Even in those plants where cleaning is performed regularly, some soot will coat the tubes between cleanings, and a noticeable rise in stack temperature occurs toward the end of the interval between cleanings.

To prevent this loss, a soot blower is the simplest answer—short of daily cleaning with a tube brush. Where soot blowers are installed, the tubes can be blown at the end of each shift, in which cases careful records show a consequent fuel economy. Low pressure plants of course cannot use steam for soot blowing, but compressed air makes a good substitute. In oil or gas fired plants, soot should be blown only while the burners are on, to ignite immediately any soot blown into the firebox. Otherwise, a quantity of soot might accumulate in a hot firebox during the absence of direct flame and ignite suddenly to create a pressure in the firebox.

Load Factors Are Important

Load factors bear an important relationship to fuel consumption. Most boilers develop their best efficiency when operating at or somewhat above nominal rating. Hence, in plants having more than one boiler, it is generally better to fire the minimum number of boilers that will carry the load—one fully loaded boiler is more efficient than two partly loaded boilers, and so on.

Adjustment of the firing rate on any one boiler justifies careful checking, for the air-fuel ratio seldom is in equal proportion throughout the entire firing range. Assuming that the ratio is most nearly correct at maximum rate, the fuel feed and the equivalent air supply should be set to the rate that will keep the controller as nearly open as possible to carry the average load. In other words, assuming a case where a 150 hp boiler is carrying a load that reaches a peak of 160 hp but averages about 115 hp, it would easily be possible to set the controller for a maximum of perhaps 200 hp, whereby the stoker or other fuel burner would quickly raise steam pressure to maximum and then throttle down to a firing rate well below the controlled maximum. In all likelihood, the consequent air-fuel ratio would then be less accurate than if the controller were set for a maximum of 160 hp, which would require the controller to remain more nearly wide open at average load instead of throttling down toward minimum.

Plan Now for Fuel Flexibility

Where conditions permit it, the plant operator should augment the flexibility of his fuel burning facilities. Plants now burning only gas can easily arrange for combination gas and oil burners, and vice versa. Plants having more than one boiler should consider the possibility of equipping one for burning coal, the other for burning oil, etc.

Some types of boilers may permit of dual firing of coal and oil, possibly with the coal grate or retort at the front, and the burner nozzle at the rear. A bit of ingenuity and planning displayed now may pay big dividends during a critical fuel supply period next winter.

STAINLESS STEEL PIPING
Why and Where to Use It

J. D. Mattimore, Chief Engineer, Product Engineering & Research, Tube Turns, Inc., Explains Applications, Standardization

THE REASONS for using stainless steel piping vary with the industry and the service requirements. Five major reasons may be assigned: (1) to provide sanitary conditions, (2) to avoid contaminating the product, (3) to prevent corrosive attack, (4) to obtain adequate impact resistance at low temperatures and sufficient creep strength at high temperatures, and (5) to hold certain fluids such as hydrogen.

Why Use Stainless?

The first reason is to provide sanitary conditions; there are many dairy, food, and drug industries which by their nature require sterile piping. Stainless steel, by virtue of its ability to take and retain a high polish, lends itself admirably to such purposes. A further consideration is that any slight corrosion products which may form on stainless steel are nontoxic.

The second reason for using stainless is that there are many processes where it is absolutely essential that the fluid handled should not be contaminated. Even relatively minor corrosion of ordinary steel or nonferrous pipe has been found to discolor fluids or change their taste. The action of the contaminating corrosion products may be direct, as by discoloration due to iron rust, or indirect as by serving as a catalyst to effect chemical changes producing clouding, sludging, etc. Such contamination may easily spoil the efforts of a manufacturer to maintain the quality or attractiveness of his product.

The third reason is to secure resistance to corrosive attack. In chemical industries there are many fluids which rapidly attack carbon steel and other ferrous materials. Nonferrous alloy pipe materials meet the requirements in some cases but in others are affected also to a greater or less extent by corrosive attack. Hence from an overall standpoint, even though stainless steel initially is more expensive, it frequently is less costly in the long run. Reduction in plant shutdown time, replacement, and maintenance costs all must be taken into account in such an evaluation.

The fourth reason is to obtain adequate impact resistance at low temperatures and sufficient creep strength at high temperatures. In this rapidly expanding technical era, processes of various types are going to lower and lower subzero temperatures on one hand and to higher and higher elevated temperatures on the other. In many such processes, stainless is useful by virtue of its remarkable retention of impact resistance at low temperatures and its relatively good creep strength and excellent oxidation resistance at high temperatures.

The fifth and final reason is related to the ability to hold hydrogen and certain other fluids which tend to penetrate through ordinary steels. Under high pressure, high temperature conditions, hydrogen penetrates in along the grain boundaries of ordinary steels and causes them to become embrittled. It may be of interest in this connection to mention that in an installation designed to handle hydrogen at 10,000 psi and 900 F, forged stainless steel, type 316, is considered the minimum grade that should be used.

There are three basic types of stainless steel: martensitic—hardenable straight chromium steels used for cutlery, valve trim, and turbine blades; ferritic—nonhardenable straight chromium steels for certain corrosive conditions where the use of nickel is undesirable; austenitic—18 per cent chromium—8 per cent nickel steels for general corrosion resistance, with addition of molybdenum and other elements for special purposes. This review of stainless steel piping is limited to the austenitic type.

Types of Stainless

Of the many varieties of austenitic stainless steels which are more or less available for special purposes, three types have been found to have general application. A survey of industries which have made extensive use of stainless steels and of pipe and fitting manufacturers has shown that these three—type 304, type 347 and type 316—should serve 95 per cent of industry's requirements. Accordingly, it is the intention of the pipe mills and welding fitting manufacturers to carry these three types in stock. The specified chemical compositions of these three types are given in Table 1.

Type 304 is the common stainless steel, frequently referred to as 18-8, meaning 18 per cent chromium, 8 per cent nickel. As may be noted in Table 1, there are minor differences in the method of specifying chemical compositions for each type in the AISI list and in ASTM specifications

THE RAPIDLY increasing demand for stainless steel piping has posed new problems for the piping designer and contractor. The author reviews reasons for the use of stainless steel in different applications and discusses the standardization of types 304, 347, and 316 as meeting the needs of 95 per cent of industry. Subsequent articles will cover selection of joints, preparation of joints for welding, welding processes, and heat treatment after welding.

for pipe, tubes and flanges, but substantially the same compositions are obtained under all the specifications. The important thing to know about type 304 is that its carbon content is limited to 0.08 per cent maximum, and the chromium is 18 per cent minimum. The reason is that the carbon and chromium contents of 18-8 type stainless steels have a strong influence on their resistance to corrosive attack after welding or in prolonged service at high temperature.

Type 347, the next most common of the three types, is for practical purposes identical with type 304, with one exception. It has columbium added to it in an amount roughly 10 times the amount of carbon, which in round figures would be 0.8 per cent; the purpose of this addition is to stabilize the steel during welding or during service at high temperatures.

What is meant by stabilization? Stainless steel, unless stabilized, has an unusual property under the influence of temperature. In the temperature range of 800 to 1600 F there is a tendency for the carbon to "precipitate" even though it be present in the steel in such a small amount as 0.08 per cent and uniformly distributed throughout the grains. Precipitation means that under the influence of temperature, the carbon is rejected from the grains, in the form of chromium-rich carbides, to the grain boundaries. This impoverishes the grains of their chromium content at their boundaries, thus reducing their corrosion resistance. It might be noted here, that this is the principal reason for maintaining the carbon content as low as possible, since the higher the carbon content, the more precipitation will take place and, in consequence, the more the corrosion resistance will be affected.

In addition, this precipitation of chromium carbides causes the metal to become brittle to a considerable extent, so that under the influence of high stress it may crack along the grain boundaries, particularly if shock or impact is involved. Columbium has a greater affinity for carbon than does chromium and hence when columbium, to the extent of 10 times the carbon content of the steel, is added, it strongly mitigates the tendency to formation of objectionable chromium carbides which migrate to the grain boundaries. However, to obtain the full benefit of the columbium addition and fully inhibit the carbide precipitation action, it is necessary to subject the steel to a stabilizing heat treatment which will be described in a later article. Many users employ the stabilizing heat treatment for severe applications. For a majority of piping services type 347, without the stabilizing heat treatment, should provide adequate freedom from the intergranular corrosive attack which is associated with carbide precipitation.

The third austenitic material most frequently employed is type 316 which differs from the two previous metals principally in that some of the chromium is replaced by molybdenum. Its normal composition is such that it has 2 to 2½ per cent molybdenum added to it.

Molybdenum has two effects. First, it helps to stabilize the steel somewhat against precipitation, although it is not nearly so effective as columbium is in that respect. Second, and more importantly, it greatly increases the corrosion resistance to some fluids. As a result, there are many applications where type 316 is far superior to either types 304 or 347. In addition, molybdenum has the effect of increasing the high temperature properties of the metal so that type 316 would be selected for severe service, such as handling hydrogen at 10,000 psi, 900 F, as was mentioned previously.

Table 1—Chemical Composition of Stainless Pipe and Welding Fittings

	C Max	Mn Max	Si Max	Cr	Ni	Mo	Columbium Min
AISI—Type 304	0.08	2.0	1.00	18.0-20.0	8.0-11.0		
ASTM—A158, Grade P8a and A213, Grade T8	0.08	2.0	0.75	18.0-20.0	8.0-11.0		
ASTM—A182, Grade F8	0.08	2.5	0.50	17.0 min	8.0 min		
AISI—Type 347	0.10	2.0	1.00	17.0-19.0	9.0-12.0		10 x C*
ASTM—A158, Grade P8d and A213, Grade T19	0.08	2.0	0.75	17.0-20.0	9.0-13.0		10 x C*
ASTM—A182, Grade F8c	0.08	2.5	0.85	17.0 min	9.0 min		10 x C*
AISI—Type 316	0.10	2.0	1.00	16.0-18.0	10.0-14.0	1.75-2.75	
ASTM—A213, Grade T20	0.08	2.0	0.75	16.0-18.0	11.0-14.0	2.0 -3.0	
ASTM—A182, Grade F8m	0.08	2.5	0.85	17.0 min	10.0 min	2.0 min	

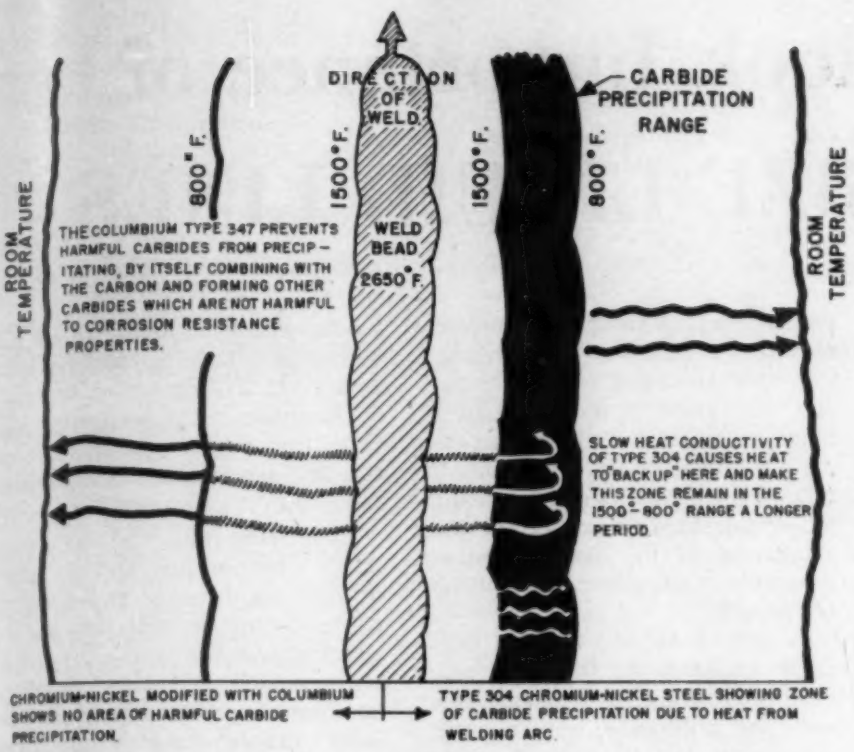
*Columbium—minimum of 10 times actual carbon content, 1.0 per cent maximum.
AISI—American Iron and Steel Institute, Steel Products Manual—Section 24, May 1946.
ASTM—American Society for Testing Materials, Standards, 1946—Part 1-A Ferrous Metals.
C=carbon, Mn=manganese, Si=silicon, Cr=chromium, Ni=nickel, and Mo=molybdenum.

The selection of the type of alloy to be used on a specific application is not simple. Type 304 pipe presently costs approximately $1.00 per lb the price of type 347 is nearly 15 per cent greater and that of type 316 about 45 per cent greater. Obviously from the standpoint of initial cost alone, the choice is not to be made lightly. And yet in many new applications it is impossible for anyone to determine in advance which type will most economically serve the purpose or, for that matter, whether any one of the three is suitable. The best solution is for the ultimate consumer to conduct a corrosion test in his own plant. In some cases, even this may not prove a complete answer to the problem, since the process in question may vary in different parts of the system or from day to day. The point is that the purchaser of a stainless piping system must assume the ultimate responsibility for the final material selection. Neither the contractor, the fitting manufacturer, nor the pipe mill should be expected to do so.

Standardization of Pipe and Fittings

In addition to concentrating on these three types of stainless steels as meeting the bulk of the requirements for stainless steels, the need for establishing dimensional standards for stainless pipe and fittings has been demonstrated. The standards committee of the Heating, Piping and Air Conditioning Contractors National Association arranged a meeting in Pittsburgh in November 1946 to which all manufacturers of stainless pipe, tubing, and welding fittings were invited. The primary purpose of the meeting was to provide a basis for a request to the American Standards Association for American Standards covering lightweight stainless pipe and welding fittings.

A preliminary schedule of wall thicknesses of stainless steel pipe based on an extension of the Schedule 10 series of ASA B36.10 from the present minimum of 14 in. down to ⅛ in. pipe size was approved as a recommendation to ASA. Schedule 10 wall thicknesses for stainless pipe and welding fittings from ⅛ in. to 12 in. nominal pipe sizes are listed in Table 2. The need for Schedule 40 stainless pipe in sizes up to 10 in. and for Schedule 80 in sizes up to 8 in. also was recognized. Both of these lines were extended to include the 12 in. size using the old "standard weight" 0.375 in. wall for the 12 in. size and old "extra strong" 0.500


DIRECTION OF WELD
CARBIDE PRECIPITATION RANGE
800° F.
1500° F.
1500° F.
800° F.
ROOM TEMPERATURE
ROOM TEMPERATURE
THE COLUMBIUM TYPE 347 PREVENTS HARMFUL CARBIDES FROM PRECIPITATING, BY ITSELF COMBINING WITH THE CARBON AND FORMING OTHER CARBIDES WHICH ARE NOT HARMFUL TO CORROSION RESISTANCE PROPERTIES.
WELD BEAD
2650° F.
SLOW HEAT CONDUCTIVITY OF TYPE 304 CAUSES HEAT TO "BACK UP" HERE AND MAKE THIS ZONE REMAIN IN THE 1500°-800° RANGE A LONGER PERIOD.
CHROMIUM-NICKEL MODIFIED WITH COLUMBIUM SHOWS NO AREA OF HARMFUL CARBIDE PRECIPITATION.
TYPE 304 CHROMIUM-NICKEL STEEL SHOWING ZONE OF CARBIDE PRECIPITATION DUE TO HEAT FROM WELDING ARC.

Stainless steel, unless stabilized, has a tendency for the carbon to precipitate in the grain boundaries in the temperature range of 800 to 1600 F. As shown in this diagram, the addition of columbium prevents carbide precipitation in the grain boundaries which causes a lessening of corrosion resistance and increases embrittlement.—(Courtesy Allegheny Ludlum Steel Corp.)

in. wall for the 10 and 12 in. sizes, respectively. It might be well to state that 8 in. is the largest seamless stainless steel pipe size in these weights which the mills can presently manufacture, although in 8 in. and smaller sizes even heavier wall thicknesses than indicated are obtainable on special order.

Returning to the subject of Schedule 10 stainless steel pipe, it should be pointed out that the effect of introducing this lightweight schedule is to cut the weight of pipe and fittings required to approximately 50 per cent of that now involved in a Schedule 40 (standard weight) installation. In addition, iron pipe size outside diameters are maintained, thus aiding the assembling of a piping system with all components based on the same outside diameters. The monetary saving thus made possible is considerable since stainless steel pipe is sold on a pound price basis and in the form of pipe and tubing approximates 15 times the cost of equally heavy carbon steel pipe. Again the standardization of pipe and fitting sizes will mean faster deliveries and considerably less cost in obtaining components necessary to complete a piping system.

Even with the appreciable saving thus made possible by the use of Schedule 10 pipe and fittings, there has continued to exist a strong demand on the part of food handling and chemical industries for still lighter grades of stainless steel because of the further possibilities of reduction in initial cost. Nominal outside diameter tubing weighing roughly one half to two thirds the weight of Schedule 10 pipe is being utilized by these industries. For some years there has been in existence a dimensional standard for such tubing promulgated by the International Association of Milk Sanitarians. In the chemical industry no attempt seems to have been made thus far to create a comparable standard. Nevertheless, some manufacturers of fittings, including the author's company, have been forced to produce such a lightweight line of fittings to supply the demand. To distinguish this line from Schedule 10 fittings, the writer's company has designated it as featherweight. This line of fittings is currently available in sizes up to and including 4 in. OD and will soon be available in sizes through 12 in. OD. While these lines of tubing and fittings are admirably suited for very mild service conditions in which soldering or brazing methods of joining can be employed, they are difficult to butt weld adequately. In addition, care must be taken because of their extreme lightness to see that the lines are properly supported and that no severe expansion strains are imposed on them. Table 2 lists the sizes and wall thicknesses of Schedule 10 and featherweight pipe and fittings.

Much Remains To Be Done

A final word on the subject of standardization will not be amiss. Much remains to be done in that field and the Heating, Piping and Air Conditioning Contractors National Association is to be commended for initiating the request to the ASA for such standards and for sponsoring them. This is the only way in which stocks of the stainless alloys in the various types of material and sizes of piping components can be made available for quick delivery. That this will have a profound effect on reducing the cost of fabricating such piping systems should be obvious.

Table 2—Sizes and Wall Thicknesses of Schedule 10 and Featherweight Stainless Pipe and Fittings

Nominal Pipe Size In.	Schedule 10 Outside Diameter In.	Schedule 10 Wall Thick. In.	Nominal Size In.	Featherweight Outside Diameter In.	Featherweight Wall Thick. In.
⅛	0.405*	0.049	—	—	—
¼	0.540*	0.065	¼	0.250	0.049
⅜	0.675*	0.065	⅜	0.375	0.049
½	0.840*	0.083	½	0.500	0.049
¾	1.050	0.083	¾	0.750	0.065
1	1.315	0.109	1	1.000	0.065
1¼	1.660	0.109	1¼	1.250	0.065
1½	1.900	0.109	1½	1.500	0.065
2	2.375	0.109	2	2.000	0.083
2½	2.875	0.120	2½	2.500	0.083
3	3.500	0.120	3	3.000	0.083
3½	4.000	0.120	3½	3.500	0.083
4	4.500	0.120	4	4.000	0.083
5	5.563	0.134			
6	6.625	0.134			
8	8.625	0.148			
10	10.750	0.165			
12	12.750	0.180			

*Not available as butt welding fittings.

Don't Overlook Importance of PROPER SIZE LIQUID LINES

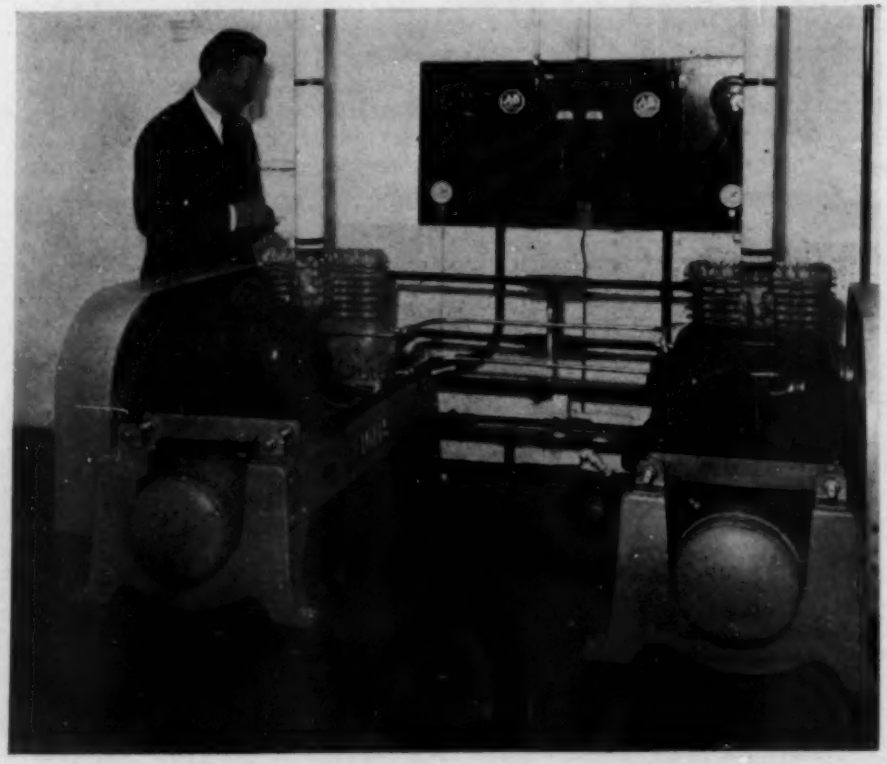
While the importance of the proper selection of size of refrigerant suction line piping has been stressed, little attention has been given to its companion, the liquid line. Although the latter is admittedly of less importance, complete lack of attention to its proper selection can also lead to serious difficulties.

It is interesting to note the similarities, and the differences, between the two piping systems of an installation. The suction line size is considered almost entirely from the standpoint of its effect on the compressor performance, its effect on coil performance being secondary and entirely due to its primary effect on the compressor. Exactly the opposite is true of the liquid line; its primary effect is on the coil, with secondary influence on the compressor. Granted that a small liquid line requires an increased receiver pressure and consequently higher discharge pressure at the compressor, with resultant reduced capacity, this effect is the result of a much more serious influence on expansion valve and coil operation. It follows then, that each line should be considered primarily from the standpoint of the major piece of equipment to which it is supplying refrigerant.

In size, of course, the two lines differ considerably, this difference being approximately commensurate with the difference in refrigerant volume in the liquid and vapor states. Also the allowable pressure drop in the liquid line can be considerably higher, since a 5 to 10 psi increase in discharge pressure has only a small effect on compressor capacity compared to a similar 5 to 10 psi decrease in suction pressure. Liquid lines are usually installed with 10 to 15 psi drop per 100 ft of tubing, with even higher values not uncommon. This imposes very little additional load on either the condensing unit or the evaporator provided that proper attention is paid to other very important considerations.

In investigating the conditions inside a suction line, and the effect of those conditions on the operation of the system, we begin with a given compressor capacity at a given suction pressure and work, in effect, backward to arrive at conclusive results. Proper study of liquid line conditions also demands that we start at the delivery end and work in the same direction.

Although the proper sizing of the liquid line is of less importance than sizing the suction line, complete lack of attention to the matter can lead to difficulties



Fundamental Purpose of Liquid Line

The refrigerant, in leaving the liquid line, passes into what has often been described as "the heart of the system"—the expansion valve. In practically all sizable modern installations this takes the form of the familiar thermostatic expansion valve, several extremely reliable designs of which are available. A great deal of competent engineering has been applied to the design of these valves and, in their present form, they perform their function with a minimum of servicing. This function is, of course, to maintain accurately, at a predetermined value, the temperature and therefore the pressure within the evaporator. The importance of this control can hardly be overestimated since the maintenance of a definite reduced temperature is the natural purpose of a refrigeration system.

The correct performance of any thermostatic expansion valve depends, however, on one fundamental factor. It must be supplied with 100 per cent liquid refrigerant. All service engineers are familiar with the operating characteristics of a system which has an insufficient charge. Since the expansion valve

is not receiving 100 per cent liquid, but a mixture of liquid and vapor, the entire operation of the system breaks down. The fundamental purpose, then, of the liquid line is to supply 100 per cent liquid refrigerant at all times to the expansion valve.

Accordingly, the pressure existing on the liquid refrigerant directly ahead of the expansion valve must exceed the saturation pressure corresponding to its temperature. If the pressure is lower than this value some of the liquid will flash into vapor in the liquid line, with consequent disruption of the operation of the expansion valve. Heat exchangers will aid immensely in preventing this, since they subcool the refrigerant below its saturation temperature, thereby reducing the pressure necessary to keep it in liquid form. However, it is poor economy to rely on the heat exchanger alone to do this, robbing it of capacity which can be much more efficiently utilized elsewhere.

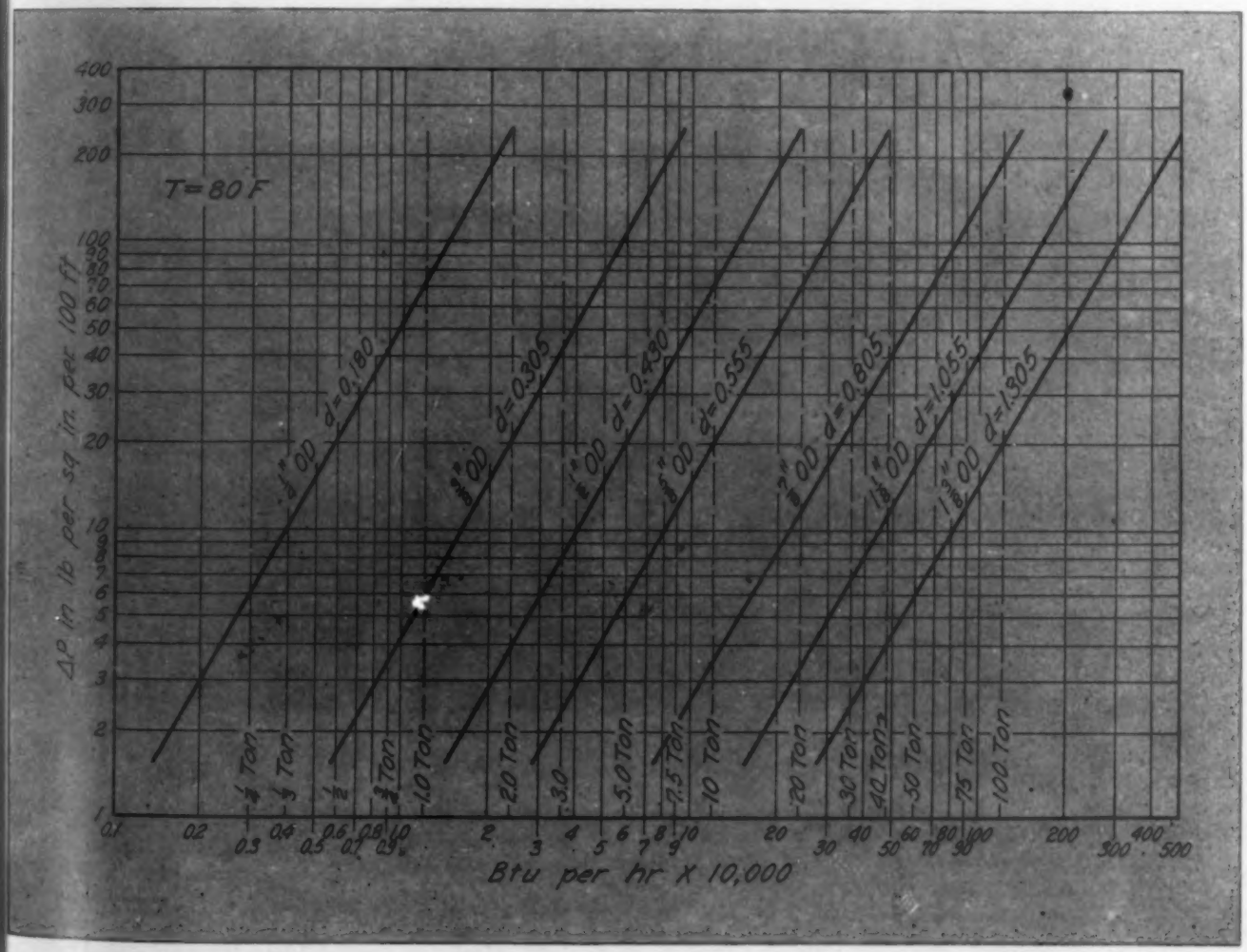
H. E. FERRILL, chief engineer of the brass division of Kerotest Mfg. Co., points out here that while proper sizing of the refrigerant liquid line is of less importance than proper selection of suction piping, complete lack of attention to liquid line sizing can lead to serious difficulties. This is particularly true in instances of extremely long lines, multiple installations with low sides widely separated, or in cases where appreciable vertical lift exists between the receiver and the expansion valve

When liquid refrigerant is flowing through the liquid line, the pressure drop occasioned by the effective length and size of the tubing exists between the receiver and the expansion valve. It is necessary, then, to maintain the receiver pressure at a value greater than the saturation pressure of the liquid entering the expansion valve plus whatever pressure drop exists. This liquid pressure drop for "Freon 12" is given in the accompanying chart. No recommendations are given as regards allowable values (as can be done with suction lines), since in this case the conditions are not as confining and are determined more by the layout of the installation.

Where Difficulties May Be Met

In most normal close-coupled installations the factors discussed above are rarely of sufficient magnitude to cause difficulty. The compressor discharge pressure, and therefore, the receiver pressure, is ordinarily set at a sufficiently high value in the interests of water economy. However, in instances of extremely long lines; multiple installations with low sides widely separated; or in cases where an appreciable vertical lift exists be-

Pressure drop vs. Btu per hr for dichlorodifluoromethane liquid ("Freon 12")



tween the receiver and the expansion valve, difficulties can be encountered and should be anticipated.

Particular attention should be paid to liquid line size in the latter instance. Refrigerant liquids are usually heavy, "Freon 12" having a density of 81.39 lb per cu ft at 80 F. The pressure existing at the top of the column of liquid is reduced by the weight of the liquid in the column. In the case of "Freon 12" this reduction in pressure amounts to 5.65 psi per 10 ft of vertical lift. In installations where the difference in height exceeds the usual amount, this pressure reduction can assume serious proportions and must be added to whatever pressure drop exists by virtue of the resistance of the tubing (see accompanying chart). Where this is a factor, the only method of definitely insuring the delivery of 100 per cent liquid to the expansion valve is by the installation of a liquid indicator directly ahead of it. This enables ready determination of the condition of the refrigerant being supplied to the valve and any necessary corrections to the adjustment of the system. An indicator installed near the receiver is of small value in these cases.

Comparison of Suction, Liquid Lines

Returning then, to a comparison between suction and liquid lines as regards engineering factors governing their selection, it will be noted that the investigation of each begins with its outlet end, since the prime consideration is the condition of the refrigerant at that point. On the other hand, the latitude of selection of the suction line is usually extremely limited and the governing factors are capacities of the major pieces of equipment. Much more freedom can be exercised in the selection of the liquid line size and the governing factors here are the layout and physical location of the major pieces of equipment with respect to each other.

Also, while the suction line has the most direct bearing on the operating characteristics of the system, it is the liquid line which contains most of the accessories and appliances which indicate and maintain those characteristics. Except for low side pressure controls, high pressure cutoffs, and pressure gages (none of which are ordinarily connected to either line) the liquid line contains practically every device intended to improve or maintain the operation of the system. These devices include such items as strainers, dehydrators, liquid indicators, charging valves, and heat exchangers which, of course, are common to both lines.

In the final analysis then, the layout and installation engineer should not consider the suction and liquid lines as simply something with which to connect one part of the system to another. He should recognize that they are definite parts of the installation which require engineering attention and consideration in order to obtain the best possible results.

[In previous articles published in the March and May 1947 issues of HPAC, Mr. Ferrill discussed the importance of fluid flow in refrigerant suction piping, and showed that undersized piping is false economy.]

ELIMINATING FUEL WASTE

By H. D. Elfreth, Service Manager, and A. MacHarg, Service Engineer, Cochrane Corp.

THE SERVICE ENGINEER in his routine calls on power plants is frequently astonished at what appears to be a disregard of fuel saving possibilities in the average plant. Many operators apparently are of the opinion that such losses are to be expected and cannot be remedied. This is surprising in view of the common knowledge that approximately 1 per cent of fuel is saved for every 11 F that the temperature of the boiler feedwater is raised. It is frequently noticed that:

1) Exhaust steam is being discharged to atmosphere instead of being used in a feedwater heater to raise the boiler feed temperature.

2) High temperature condensate is being discharged into low pressure receiving tanks vented to atmosphere or into open hotwells.

3) The blowdown from boilers is being discharged directly to waste instead of through a heat reclaiming system.

4) Even in plants where feedwater heating equipment has been installed, faulty installation or operation occasionally prevents securing the saving for which the unit was purchased.

In a recent inspection, a deaerating heater designed to operate at 10 psi and to heat the feedwater to 240 F was found to be delivering water to the boiler feed pumps at 100 F, this deficiency in temperature representing a fuel loss of 12 per cent. The reason was found to be that the heater had been installed at such a low elevation that there was not sufficient static head for adequate pumping without flashing. The heater is now being raised so as to secure the proper static head on the boiler feed pump suction and to permit operation at the designed 10 psi pressure. This will increase the feedwater temperature to 240 F and insure satisfactory deaeration.

It is also a common experience to find traps draining live steam separators or steam headers discharging to waste or to atmospheric receiving tanks or hotwells. The condensate should be discharged to the connection provided on the feedwater heater, thus not only saving the water itself, but utilizing the flash steam from the high temperature condensate for heating the cold makeup water. It is surprising to find a number of plants still blowing down their boilers directly to waste, and on some erratic schedule determined by the judgment of the operators. The use of a continuous blowdown system would not only result in the maintenance of a uniform concentration in the boiler but would also reclaim the heat in the blowdown water which is otherwise going to waste. The following suggestions will serve as a check list in determining the savings possible in any particular plant.

1) *Maintain a High Feedwater Temperature*—Recover exhaust steam that might otherwise be

(Concluded on page 94)

Frank H. Slade Describes Heating of the Burgerspital, Basel, Switzerland

High Pressure Hot Water Serves Hospital Project

OPENING OF THE new building at the General Hospital, Basel, Switzerland, some months ago brought to a successful conclusion a very large-scale project in spite of the difficulties occasioned by the recent war. The construction of the building was commenced in 1940.

Heating is by means of high pressure hot water supplied by the district heating system of the Basel Electricity Works.

Heat Comes From Three Sources

Heat is furnished from a combination of three sources—a refuse burning plant, superfluous electrical energy, and solid fuel. The refuse burning plant was installed with due regard to the hygienic and economical advantages offered, while in addition, the Basel Electricity Works operates a steam exchange with large coal heated boilers, which was built in 1903 as an emergency heat reserve station to function in the event of a breakdown of the electric supply, which is brought from a considerable distance. This is in the immediate neighborhood of the two main stations supplying power for the municipal high voltage system. Electro-steam boilers which are utilized for the conversion of any superfluous electrical energy into usable heat are also incorporated in this plant, and in addition, the available boiler plant is suitable for generating any needed additional heat.

The refuse burning plant and the steam reserve plant are connected for the generation and supply of heat to various consumers. These work together in the following way: Customers obtain, first, heat from the refuse burning plant, and second, superfluous heat available at the electricity works, while additional requirements are covered from the coal fired boiler plant. The existing heating plant in the old hospital was retained as an emergency plant.

The high pressure hot water supply at a pressure of 220.5/294 lb per sq in. and 212-356F is fed to the hospital heat exchange room by insulated seamless pipes in concrete ducts. The length of pipes from the refuse burning plant to the heat exchange at the steam reserve plant is about 3280 ft, and from there to the hospital about 3610 ft. The water after use is returned to the district heating plant at a temperature of approximately 176F.

In the hospital, the distribution of heat for process uses, room heating, and hot water supply is regulated and supervised from a central position—that is, the heat exchange room with its pumps, apparatus, switchboards, and extensive piping network is accommodated in the three floors under the kitchen. This method of grouping was

HIGH PRESSURE HOT water from the district heating system goes to the heat exchange room of the General Hospital, Basel, Switzerland, and from there the heat is distributed for process use, panel and radiator heating, heat supply to the old hospital buildings, and service water supply. Heat is measured by venturi meters and recording thermometers, one set being supplied by the district heating concern and the other by the hospital; if they don't agree within 5 per cent, an official investigation is made by mutual agreement.

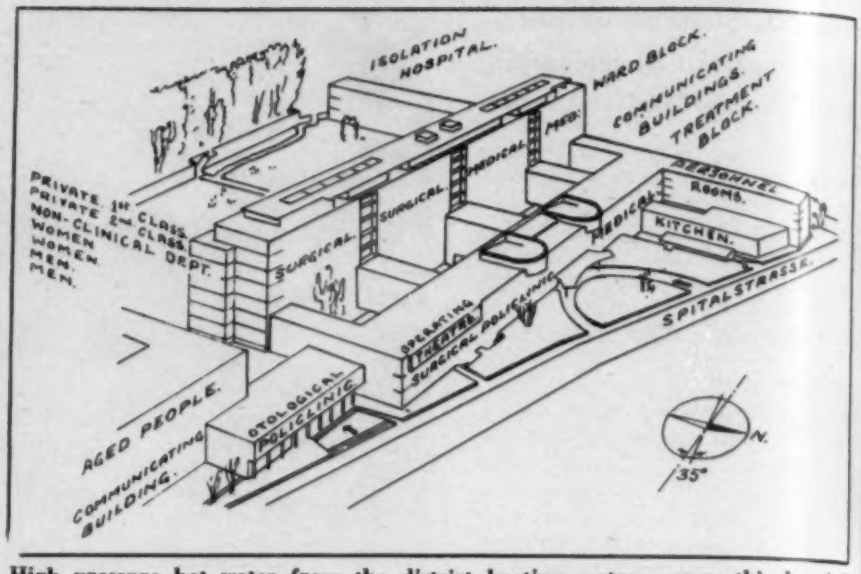
adopted to facilitate maintenance and supervision of the system.

Two Sets of Heat Measuring Instruments

The quantity of heat consumed is measured at a point where the now and return pipes enter and leave the hospital, one set of measuring instruments being supplied by the district heating concern and the other by the hospital authorities. The method employed is to measure the flow by venturi meter and the temperature difference by recording thermometers. Should there be a discrepancy of more than 5 per cent between each set of measuring instruments, then by mutual agreements an official investigation is made.

A further duty carried out in the heat exchange room is that of limiting heat consumption, for owing to technical reasons it is necessary for the district heating concern to limit heat consumption to a certain maximum. In the event of the hospital system being closed down, starting-up losses are avoided by the mass circulation of water through a by-pass fitted on the supply side of the metering apparatus.

The system feeds a steam producer operating at 29.4 lb per sq in., connected in series with two heat exchangers employed for feeding a hot water accumulator, heat exchangers for supply of hot water to the hospital heating system (i.e., panel heating), a heat accumulator large enough to take 8 hr "shut-down" load, decentralized ventilation for certain sections, and further steam producers for additional steam feed at 14.7 lb per sq in. Five



High pressure hot water from the district heating system serves this hospital project in Switzerland

horsepower pumps, with reserve units, are employed for distribution of water to the various networks.

Distribution of the Heat

The distribution of heat from the heat exchange room is divided into four groups:

1) High pressure hot water supply for process use.

2) High pressure hot water supply to heat exchangers for panel and radiator heating.

3) Supply of heat to the old hospital buildings.

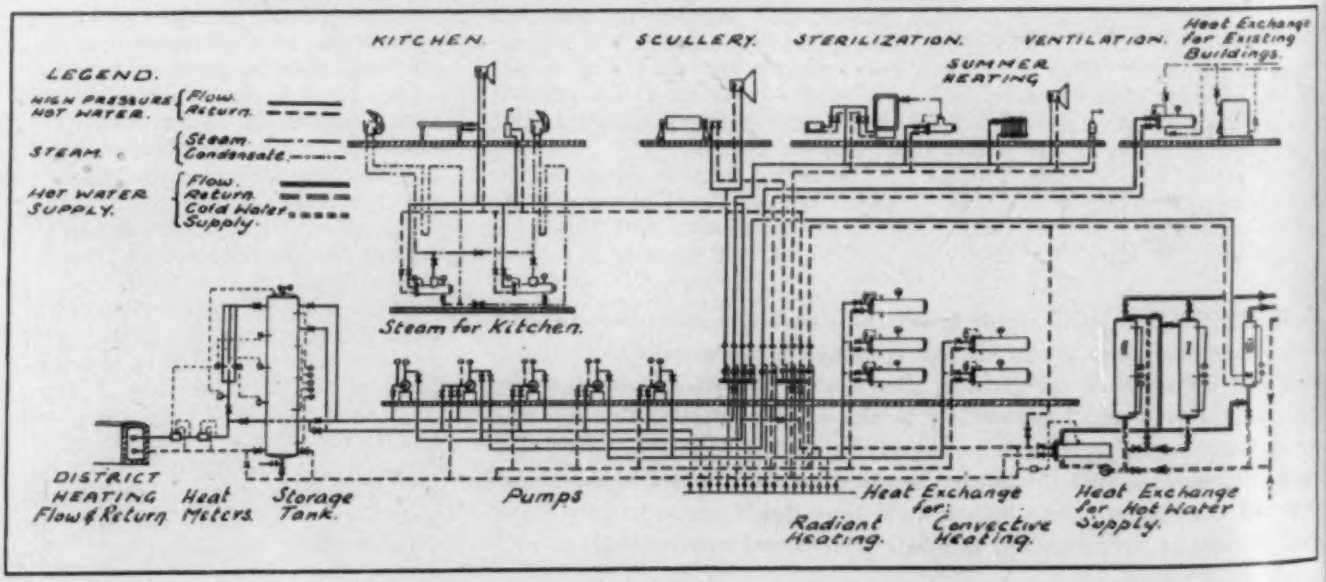
4) Service hot water supply.

Enlarging upon these various groups, Group 1 includes sterilizing equipment, kitchens, sculleries, and warm air supply for ventilation. Where specially required, this equipment operates at a temperature of 338-356F, enabling steam at 36.75 lb per sq in. to be generated, and as this plant is in operation for the whole year it is also connected to the summer heating system.

This network can be fed from the district heating system by bypassing the heat accumulators and the pumps in the heat exchange room, thereby facilitating summer operation when there is no danger of overload. The system operates at a feed pressure of 264.6 lb per sq in.; thus, with hot water at this relatively high pressure and correspondingly high temperature, considerable attention must be given to valves, etc.

Group 2 is comprised of two divisions—heat exchangers for the supply of hot water to the panel heating system, and heat exchangers

Distribution of heat from the heat exchange room is divided into four groups: hot water supply for process use, heat exchangers for panel and radiator heating, supply to the old hospital buildings, and service hot water supply



Heat exchange room, showing circulating pumps

for the supply of water to those points where radiators are employed. Panel heating is utilized for the ward and treatment blocks.

The distribution for the old hospital buildings, Group 3, is connected separately, for careful regulation of temperature is necessary in order to avoid as far as possible heat losses. Group 4 is for hot water supply for the whole hospital.

The heat of the return feed water is partly used in the centrally arranged plant; it flows counter to the cold water, and is cooled to the necessary low return temperature. Interconnection with the high pressure hot water feed to the industrial heating plant by hand regulated valves supplies a means of mixing high temperature hot water with the return feed water, thus supplying a primary heating medium that will produce the required temperatures at the secondary flow. The heat exchangers are fitted with automatic temperature regulators and also signalling apparatus for indicating breakdown.

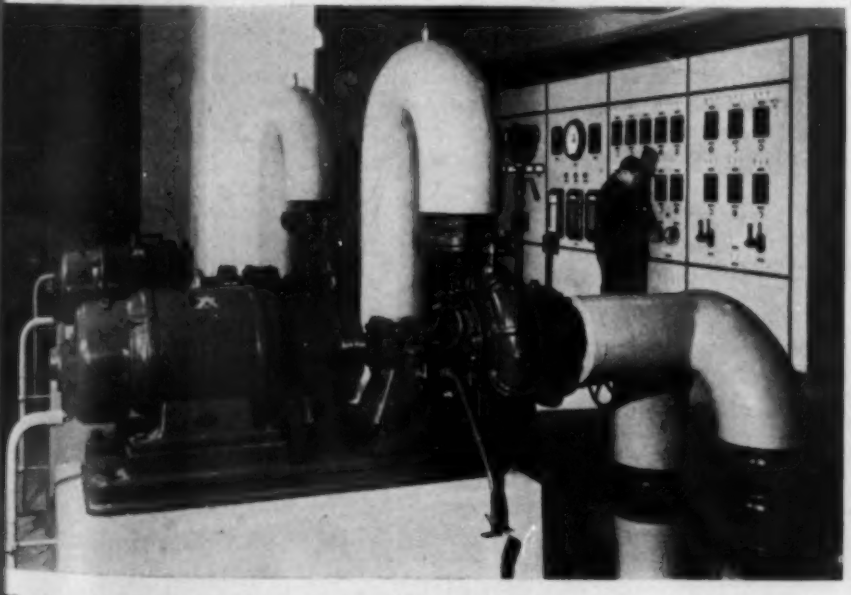
Careful attention was paid to the choice of a room heating system, and after detailed investigation a decision was reached in favor of a panel heating system for all sections of the building with the exception of the kitchen wing. It is interesting to note that the panel heating system at this hospital is believed to be the largest in Europe.

The pipe grids are plastered into the bearing sheets with a concrete covering of only 0.59 in. to form the heat radiating elements, while the concrete functions as a heat distributor and heat retainer.

The heating coils were manufactured of pipe welded to grids on 5.9 in. centers; these have an outside diameter of 0.835 in. and an inside diameter of 0.610 in. The feed pipes are fitted for the greater part in the corridor main supports and in certain inner walls; longitudinal facades are not utilized but the cross facades carry two each, adequately protected from the outside. The relatively small expansion vessels employed are situated in an oblique position in the ceilings.

In addition to the normal insulation of pipes against heat loss, floors are covered with insulating mats (sisal fibers between tarred paper) in order to protect the radiant heating in the ceiling against loss of heat upward. For the same reason the roof terrace was insulated with approximately 2 in. thick cork sheets; this is of course, apart from the very stringent methods taken to insulate the building from street and other airborne noises.

This close-up of the 5 hp pumps shows the master control panel in the background



Heating in the Kitchen Block

There are four methods of heating employed in the kitchen block; these are:

1) Hot water at 338F from the district heating system. This is employed for hot plates, towel dryers, coffee water boilers, potato steamers, etc.

2) Steam at a pressure of 11.76 lb per sq in. gage, employed for 30 tip boilers, coffee machines, sterilizing troughs, plunge and dishwater.

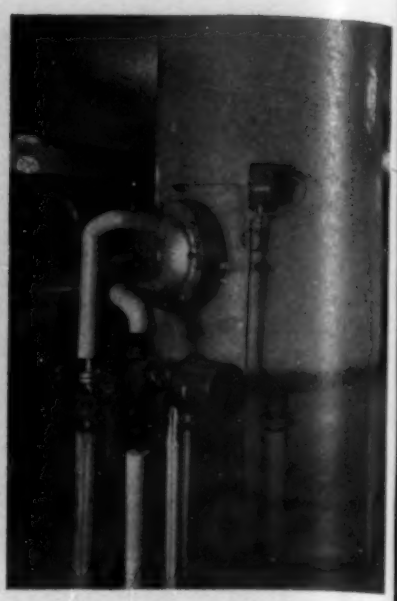
3) Gas for two large stoves, two grills, four tip frying pans, and four hot plates.

4) Electricity for ovens and two tip boilers.

The main kitchen is directly connected to the municipal high pressure main, reduced pressure being secured by means of a pressure reducing valve calibrated to a pressure storage tank for the mixing header in the kitchen, from which a correct temperature of hot/cold water mix is secured. Both hot water heat exchange and kitchen heat exchange units are also fed with reduced pressure hot water.

Various apparatuses are connected directly to the district heating hot water system at 356F or to steam producers employing this water at the primaries, such as the kitchen, the warming cupboards in the ward block, and various equipment in the physiotherapy block, the treatment block, sterilizing apparatus, autoclaves for bandage sterilizing, drying cupboards in the

Heat exchangers serving the hospital



Automatic control equipment for hot water supply heat exchanger

laboratories, summer heating system for the operating theaters, and supplementary heating for the clinical lecture rooms.

The laundry in the old hospital must be operated until some future date with hot water because the coal required for the plant existing in this department was not available during the winter of 1945-6, although the steam showers and steam baths in the physiotherapy department are supplied with steam generated from high pressure hot water, as are also autoclaves in the operating theaters, various equipment in the laboratories, and parts of the kitchen.

In the old hospital, the disinfecting department, various pieces of equipment in the dispensary and the calendar in the laundry, are steam heated.

The ventilation system is decentralized, and since ceiling heating produces a comfortable atmosphere, which together with natural ventilation, answers all requirements, very simple artificial ventilation is found only in the following groups: Ward block, X-ray and physiotherapy department, in wards, in rooms of two beds, treatment block, clinical lecture rooms and animal rooms, kitchen, diet room, milk and coffee room, storerooms and food preparation room. The type of ventilating unit employed supplies fresh air of the correct temperature to individual rooms and is fitted with automatic temperature control and remote control of the fan units.

Exact control of temperature is a predominating feature of the plant throughout the whole of the hospital installation, as is the use of all automatic equipment that leads to economic and foolproof operation. Modulating control is employed (thermostat-differential relay-modulating control and in certain cases "on-off" control (motorized).

Indication for failure is by lights which are fitted to the central control panel. Red indicates plant failure, which, when switched off, automatically operates a green light, this signal remaining until repairs are effected. The lights are so arranged on the panel that they will show the actual circuit where repairs are required.

In addition to indicating all technical data required for the successful operation of the heat exchange plant, temperatures in different parts of the hospital are indicated by distance reading thermometers. This is very necessary in view of the size of the hospital, for it would not be possible for personnel to properly control the feed temperatures, and thus operate the entire heating system economically, if this apparatus was not employed.

[The author wishes to express his indebtedness to Schweizerische Bauzeitung, Messrs. Sulzer, Winterthur, Elektrizitatswerk, Basel, and Messrs. Sauter of Basel, for permission to use data and photographs forming the basis of this article, and in particular to Mr. Jack J. Studer of Messrs. Sauter S.A., whose assistance in securing permission to view the hospital and in accumulating data relevant to the project is more than appreciated. Photos reproduced with this article are by Peter Heman and Dr. W. Brückner.]

Gas Revenues Gain 18.1 Per Cent

Total revenues from sales of gas by utilities in the second quarter of 1947 were $333,000,000, an increase of 18.1 per cent over the comparable quarter in 1946, the American Gas Association has reported. Revenues from commercial gas sales showed the highest percentage gain, rising 27.8 per cent. Residential and industrial gas revenues increased 15.7 per cent and 19.8 per cent respectively. In the 12 month period ending June 30, 1947, revenues for all branches of the gas utility industry totaled $1,313,800,000 a gain of 13.4 per cent over the previous year.

The number of customers served by the gas utility industry in the second quarter totaled about 21,000,000 a gain of 2.5 per cent over a year earlier. Increases were recorded in all three consumer classifications, with the commercial customer classification showing the largest of the gains, a rise of 9.4 per cent.

The piers, yacht harbor, and business district of Wellington from Oriental Bay. Note how high the surrounding hills are. As in San Francisco, the houses are perched on the sides of steep hills and any place else where a foundation will hold. Access to many of the houses is by means of high winding steps in the sides of the hills

John H. Clarke Tells of Practical Piping and Pumping Problems

Design Engineer Reports on Operating Experience

WE FINALLY managed to get straightened out and ready to sail for Abadan, but our departure from Wellington was restricted for 12 hours to give the port authorities a sporting chance to pick up the members of our crew who had jumped ship, or otherwise had neglected to rejoin the brethren.

We had rough riding until we rounded the western end of Australia and got well out into the Indian Ocean, but for the greater part of the trip the water was glass-smooth with an almost imperceptible groundswell. We were running into what little breeze there was and managed to stay remarkably cool. The ocean skies during this phase of the trip were beautiful beyond description. Occasional squalls would ride across the horizon or sweep around us, but for much of the time skyscraper-like clouds provided us with a continuous panorama of castlelike buildings, piled one upon the other, for the full 360 deg of the horizon.

In addition, we were entertained most of the way by the antics of the whales (which are very numerous in the vicinity of the Australian continent), the porpoises, and the flying fish. Many of the latter made unscheduled crash landings on our weather deck. We picked one up with a wingspread of about 15 in.; most of them were smaller, however. It was amazing to see the way that they could take off, glide, and get up steam for another glide by wriggling their tails in the water without landing. It's quite an act, especially when one of them misjudges a wavelet and turns several undignified back flips.

Trouble With Fuel Oil Backpressure Valve

While the weather and the scenery on the way to Abadan were superb, the time we had in the engineroom was anything but happy—our troubles were numerous and varied. For one thing, the fuel oil pumps were continuing to give us trouble. Each one, of course, was supposed to carry the full load of both boilers and have ample capacity to develop 300 psi with some oil being recirculated by the backpressure regulating valve. On the leg to Abadan, we seldom were able to get more than 200 psi, with reduced power (88 rpm) and a burner pressure of 160 psi. We were still using No. 46 atomizing tips. Several times the relief valves on the fuel oil pump stuck open and we lost pressure on the system.

The probable cause for the relief valves opening was this: The second assistant was keeping the backpressure regulating valve screwed down to be sure no oil went through the valve. At any time we would have a change in power resulting from a change in speed or tank cleaning, such that the steam requirements were substantially reduced, the combustion control valve would close and the pump pressure would immediately rise until the pump reliefs let go. One time a rag was found in a relief valve. No explanation was forthcoming for the other times the valves stuck.

In any case, the reliefs were at

WHAT ARE THE problems with piping systems, pumps, valves, heaters, controls, and other mechanical equipment faced by the operating man? How do designs perform in service? How is the equipment actually operated? The answers to these questions were among the author's objectives when he (a marine design engineer by training and profession) shipped on a tanker as junior third assistant engineer. By the time his seagoing phase was completed (he's now back on land as a design engineer with the Standard Oil Co. of Indiana) he got plenty of practical information on piping, pumping, heating, ventilating, and other subjects. His comments and observations on much of his experience are continued here from our September issue. A lot of what he found out applies not only to marine work but to the design, operation, and maintenance of mechanical equipment in plants and buildings as well

one time or another screwed down so that they couldn't open. This, of course, was not good inasmuch as reduced fuel requirements at the boilers would overload the pump in service. The second engineer was finally persuaded to leave the backpressure valve at a set position, just over the required burner pressure, but under the maximum pressure that the pumps would develop. In this way, we could avoid overloading the pumps and getting into other difficulties with them. Usually we set the backpressure valve at about 175 to 180 psi. This valve, which was of the diaphragm operated type with an actuating line taken off the fuel oil service piping ahead of the combustion control valves, gave excellent service for the entire trip.

Several times when we had difficulty obtaining sufficient oil pressure with one pump, we operated with two pumps. Under these circumstances we could still get only a maximum of about 250 psi. However, we had to check the pumps carefully while they were operating in parallel. Several times one pump would back the other off the line with the result that it would overheat considerably. These pumps were of the screw type.

Trouble with the fuel pumps was precipitated on several occasions during a change-over of the steering engine pumps. As usual on this ship, no one was notified that a change-over was contemplated. The first that the watch officer knew about it was when he got a stop bell. The bridge had ordered the stop when the rudder had gone hard over and the ship had started to go in a circle.

It was learned later what was going on. The first engineer and the chief were changing over the steering engine pumps but had neglected to tell anyone about it. A week later another change-over was attempted with the steering engine. This time the engineroom was notified but not the bridge. Again the rudder went hard over, and again we got a stop bell in the engineroom. We had a steering engine of extremely simple design and ordinarily no difficulty is encountered on most ships during such a change-over. The usual procedure was to alternate steering pumps about once a week to once a month. We never changed for the entire trip, except for the two above mentioned attempts to change over.

Disagreeable Task—Cleaning Cargo Tanks

The reason that we had trouble with the fuel oil pump during the above emergencies was that no one had told the fireman that the oil backpressure regulating valve was screwed down. Consequently, he had no reason to expect a sudden rise in pump discharge pressure. But the sudden stop caused the pump relief valve to open, and it stuck open, as previously mentioned above. As a result the fuel oil pressure at the burners was immediately lost and it was necessary to change to the standby pump. In the meantime, the fireman had been very busy cutting out burners, and checking the feed to the boilers. Of course, we got straightened out shortly but with better teamwork such trouble would have been minimized.

One of our disagreeable tasks after leaving Wellington was to clean our cargo tanks. On ships where the patented equipment is used, this is accomplished by "Butterworthing".

Each tank is provided with an access plate. This is removed and a fixture with a 90 deg arc and semicircular groove is bolted down at the access hole. The Butterworth machine is then attached to a special 2 in. hose and raised and lowered in the tank in order to spray the entire tank with hot salt water. These machines are designed somewhat like a water-operated lawn sprayer. The gear arrangement is such that the nozzle assembly rotates in a horizontal plane. The two nozzles themselves rotate in a vertical plane, thus covering the entire tank. The operating impulse is provided by the reaction at the nozzles, which are eccentric with respect to the center of rotation.

Here again, the inexperience of the crew caused us no end of trouble. Because of this it took us 10 full days—spread over two weeks—to clean the tanks when this should have been done in about three days. To begin with, the crew didn't raise and lower the Butterworth machine. They parked it in one spot and left it there until ready to move to another tank. Also, we operated at only about 110 psi pressure and 140 F (this was later raised to 175 F), whereas the system is designed to operate at 200 psi and 200 F and is usually operated at 180 psi and 180 F. This made a considerable difference in the cleaning. The water was heated by a heater and a heater-drains cooler, the two operating in series. Water was provided from the sea by means of the fire pumps, using the fire mains to the hose outlets. We used only one fire pump and this appeared to be *capable* of developing the full pressure of 180 psi for the system. However, the piping was designed so that the two fire pumps could operate in series, if necessary, in order to maintain full pressure when using a number of the Butterworthing machines. We used two at a time. We had three on board but we were repairing one of the three for most of the trip. These were old machines, in poor condition, and should have been turned in for new machines prior to starting the trip; such renewal is a part of the rental service for the machines.

Difficult to Control Temperature by Hand

We had a temperature control valve of the self-contained type for controlling the water temperature from the heaters but, like many other valves on the ship, it was inoperative. Apparently the power element had failed, releasing the

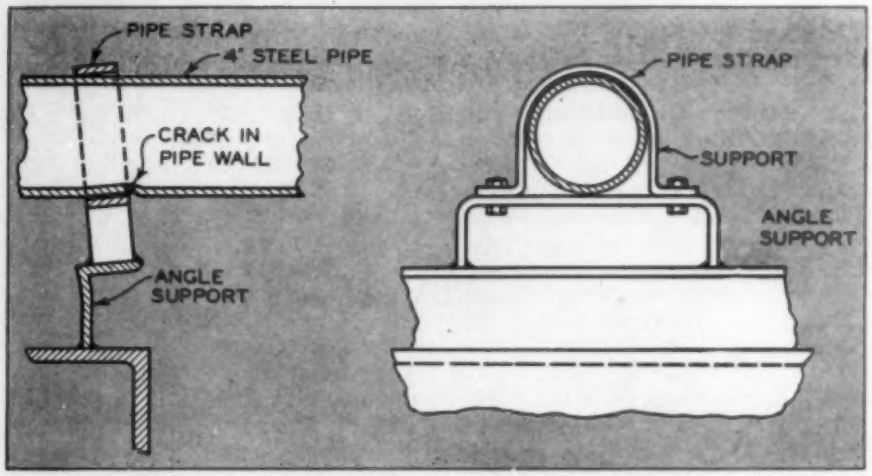
actuating fluid, so we had to control the temperature manually. This also caused trouble. Whenever the deck crew changed the volume of water being used, the temperature changed. Whenever they shut off a machine to move it to another tank, the temperature sometimes went as high as 270 F before we caught it. Then when the deck valve was opened, the temperature of the water in the heater would drop down suddenly to about 70 or 80 deg. depending on the sea temperature. These were floating head heat exchangers or they would have been torn to pieces.

We tried to persuade the deck boys to open a deck valve in the fire main when they wanted to shift the machine to a new tank, for in this way we would not have had to touch the steam adjustment. The temperature would drop when they opened the deck valve, and when this was closed as the Butterworth machine was put into operation, the temperature would rise to the normal operating point. This latter method would have simplified the pump operation also. As it was, everytime they shut off the water, the pump pressure would rise. We managed to keep the relief valve from popping, but it kept us moving to do it.

There were several other items of interest regarding this equipment. The drainer for the heaters was inoperative (as were most of our other drainers) and would not close tight enough to maintain the design water level. As with the other drainers, this was never opened for cleaning. However, the handwheel was operated frequently to try to clear it, and evidently was operated a bit too violently. Prior to the end of the trip the body end plate was removed and it was found that the ball float had been torn loose from the operating lever.

As another item, many of the Butterworth heaters had failed on similar ships because of steam leaking into or being turned on the heaters while they were secured (suction and discharge valves closed). Later ships had been provided with relief valves. However, we did not have a relief valve on our ship, and the bypass valve around the steam control valve leaked. This was evident from the heat at the unit and from the condensate that would collect in the drainer.

In any case, the water was heated sufficiently high on one occasion so that it had expanded and was leaking out the head flanges. When



Left—Longitudinal cross section of pipe at support, showing the damage to the pipe caused by the pipe strap being too tight, which in turn caused the strap to freeze and cock. . . . Right—Detail of pipe support at the point of the break. This type of support was typical throughout the ship.

this was discovered, the discharge valve and overboard valve were opened and left open so as to positively relieve the pressure. The bypass valve was also sealed by the means of gasket compound. An attempt was made to grind it in, but it was reported that the seat was either badly warped or otherwise damaged so that it could not be ground in.

There was some difficulty in convincing some of the engineroom personnel that it was necessary to relieve the pressure on the above heaters in case they became heated up by leaking steam. To them it was a nice theory, but that was all. Of course, they could observe the same expansion on the boilers when they were brought up from the cold state, but they didn't seem to see the similarity.

Underfrequency Relay Trips Out Pumps

During the cleaning of the tanks it was necessary to shift ballast from tank to tank and to pump out the oily water from the tanks being cleaned. This was done by operating the main cargo pumps off the main turbogenerator. To have done the same job on auxiliary generator power would have required the operation of two generators, so we always operated on main power when we could. The operation of the cargo pumps brought about a rather amusing situation. There was an underfrequency relay provided on the pumping panel so that the pumps would be automatically tripped out at about 45 cycles. Because our fuel oil pumps did not provide any margin for power, we were forced to slow down the ship while Butterworthing. The additional power for pumping slowed us down just that much more. As a result, the pumps tripped out once because we were unable to operate the main generator in excess of the necessary 45 cycles. This occurred the same day we had the steering gear trouble. And incidentally, when we stopped for that emergency, the pumps also tripped out. As can be imagined, we had quite a time trying to complete the tank cleaning, because it was necessary to operate so that we were not Butterworth cleaning and pumping at the same time.

It was our custom to change over auxiliary generators on our ship about once a week. Usually this was done on my watch. The main reason in this case was that the second and third engineers wouldn't work with the first engineer in doing the job. Being low man on the squad, I couldn't be quite so fussy, so I suffered through the ordeal regularly.

It is ordinarily the first engineer's job either to make or to oversee the change-over. In this case, he usually did enough of the change-over to get things all lathered up, and then left the finishing of it to someone else. He was an impatient fellow who could never wait to check anything or notify anyone, so frequently something happened. The firemen dreaded to see him around because they never knew what to expect.

In one case, he tripped out the main unit for the change-over without the bridge or the fireroom being

notified. I was on the phone trying to contact the bridge, but didn't have time to get an answer so the fireman was never informed at all. The subsequent shutdown was nearly sufficient in each case to cut out the fires on the burners, or at least to cut the pressure to the point where the burners would dribble oil all over. Such a situation was not exactly safe, and my fireman much preferred to cut out his burners as necessary during the change-over.

Synchronized "On the Fly"

The first assistant finally topped off his long and dubious record with an allstar performance. In paralleling the two a-c generators preparatory to shifting the load and excitation to the standby generator, he neglected to balance his voltages. In addition, the incoming generator was turning over at a considerably higher speed than the operating unit. He synchronized the two "on the fly". The result? . . . He cleaned both of them off the board. Fortunately, we had reverse current relays *and they worked;* otherwise those generators would be in a thousand pieces by now. This precipitate method of generator change-over was *another* cause of the fuel pump trouble mentioned previously.

About halfway to Abadan, the second engineer attempted to change over to the forward feed pump (the one that had been repaired at Baltimore and at Balboa). On this occasion it refused to develop the full head, the maximum being about 350 psi. Ordinarily it should have developed about 500 psi at this load. The aft pump was put back into service and the upper casing of the forward pump was removed for inspection. There had been a considerable history of interstage cutting with these pumps and it was suspected that this was the trouble. This was given as the official explanation, but personally no such cutting was observed. In any case, it was decided to leave the pump open for repair at Abadan.

"A Million Dollars for Bearing Thermometers"

Our auxiliary feed pump which had been giving us trouble was getting worse despite much time being spent on it. The linkage for the valve actuating mechanism was twisted so that it would cock on the valve rod. Thus, when the rod was moved up, it would be immediately pulled down again, causing the pump to "short stroke." Our one remaining feed pump had been in almost constant operation since leaving Baltimore and we were not at all certain as to what condition it was in or how long it would last. At times like this we would have given a million dollars to have had a set of bearing thermometers. It is hard to understand why these pumps had not been equipped with them in the first place. This obvious error *was* corrected on later ships. As an emergency measure, we kept the auxiliary feed pump lined up in case of trouble, hoping that if an emergency did arise it would be of some help.

About a week before arriving at Abadan (the trip took 24 days), we transferred water and oil aft. At this time it was discovered that the 4 in. cargo oil heating line (which also provided heat for the forward bunkers) had cracked at one of the pipe straps and was leaking considerably. The line was secured and a temporary jumper was provided from the deck steam line to the connections for the forward fuel tank heating coils. An inspection of the cracked cargo heating steam pipe showed that, as with all of the other deck piping, the pipe strap had frozen to the pipe and did not permit it to expand freely.

Frozen Pipe Straps Cause Cracking

The expansion joint just aft of the strap was also severely rusted so that it could provide only limited relief for the movement of the pipe. Consequently, the support angle flange for the pipe strap had been bent up about 10 deg, and the flat bar to which the pipe strap was directly attached had bitten into and creased the pipe. The crack was across this crease and extended for about two-thirds of the diameter.

Shortly after the above incident, the deck exhaust steam line buckled just aft of the midship house. In buckling, it cracked at a brazed joint for a branch to one of the deck winches. That it did no more than crack may be attributed to the fact that this 5 in. line and the 3 in. line to the winch were made of copper. The line buckled down fully 6 in. This again was caused by the pipe straps and expansion joints being too tight or in such poor condition as to prevent proper movement of the pipe through the supports during expansion and contraction and while the ship was working (hogging and sagging) as it went over and through the waves.

FUEL WASTE—

(Concluded from page 86)

wasted by utilizing it in a direct contact open or deaerating feedwater heater. Do not allow any steam to escape to atmosphere that can possibly be used in the plant.

2) *Recover the Heat in Boiler Blowoff Water*—The steam flashed in flash tanks can be used in the feedwater heater or process lines. Heat exchangers recover the remaining heat in the blowoff water before discharging it to sewer.

3) *Return All Condensate to the Boiler*—If oil-contaminated, remove the oil from the exhaust with a steam purifier or pass the condensate through an oil removal filter. To run condensate to the sewer is sheer waste of heat and water. Enter trap discharges and heating system returns to the open feedwater heater. Avoid loss of flash steam in open receivers and hotwells. Return high temperature condensate from corrugators, dryers, process kettles, etc., directly to the boiler by the use of a condensate return system.

4) *Reduce Moisture Content of Steam*—Steam purifiers can reduce the moisture from 5 per cent or more down to less than 1 per cent, resulting in dryer, hotter steam.

5) *Check Boiler Water Treatment*—Accumulation of scale on any heating surface seriously restricts the transfer of heat and such deposits are a major cause of boiler troubles in addition to waste in fuel. Corrosion is both dangerous and costly.

6) *Keep on the Watch for Steam and Hot Water Leaks*—A ⅛ in. diameter steam leak in a 100 psi line will cause the loss of over 50,000 lb of steam in a month. Make sure that all valves in steam line close tightly.

7) *Insulation or Lagging*—Keep all piping and steam using equipment properly insulated to cut down heat losses.

8) *Practice Preventive Maintenance*—Don't wait until trouble catches up with you. Be on the lookout for it. Keep a reasonable supply of replacement parts on hand, as they are often difficult to secure when you have a breakdown. Make use of all available instruments, and regularly check the efficiency of your equipment with them. Avoid overloading boilers above their efficient operating rate. Keep furnace baffles tight and use soot blowers regularly.

"OPEN FOR DISCUSSION"

85-BELOW-ZERO REFRIGERATION PIPING

WE NOTE WITH interest the article on page 80 of the July HPAC, entitled 85-Below-Zero Refrigeration System Being Installed at Kodak Park.

We draw your attention to the third paragraph, from which we quote: "The pipe will be of nickel steel because ordinary steel tubing becomes brittle at the extreme temperatures in which the system will operate".

We would like to have you amplify the above statements since they seem to us somewhat illogical. Although we have not worked directly at —85 F temperatures we have built a considerable number of heat transfer units which have undergone tests at Wright Field at —67 F and we have never had a metal failure even on lead-tin soft solders. The writer has also spent one winter in Alaska at the Air Corps cold weather test station at Ladd Field where temperatures have been recorded as low as —72 F and the only failures reported have been those on organic materials such as rubber, certain plastic parts, gaskets, etc. In addition it is fairly common practice today to carry on supplementary "heat treating" of steel at —125 F.

Can it be that nickel steel tubing is being used to offset the corrosion tendency of the "brine"? Also what "brine" solution is being used at —85 F?

REPLY—The following comments were prepared by the engineer in charge of this project to answer the above questions:

The major portion of the brine system is of 18, 16, and 12 in. pipe. Since the present system will have about 50,000 gal of expensive methylene chloride brine at —85 F, extra precautions were taken to insure against breakage of the mains due to temperature stresses.

The charpy value of cast iron is approximately 0 ft-lb. SAE 1035 carbon steel has a value of approximately 5 ft-lb at —100 F. Our nickel steel pipe is about 16 ft-lb at the weld and 28 ft-lb in the base metal. In some of our small and unimportant lines we are using plain carbon steel pipe.

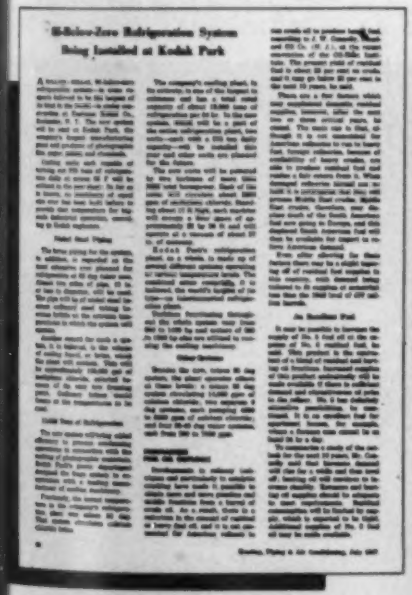
We have seen extensive installations with up to 14 in. mains carrying methylene chloride at —94 F where carbon steel pipe was used. One installation used extra heavy and another standard weight pipe. Trouble was experienced in starting up with cracked mains due to temperature stress in one of these installations.

Our straight runs of pipe are of such length that expansion loops are required. We believe the nickel pipe will stand such stresses better than carbon steel pipe would.

Methylene chloride brine is not a corrosive substance except in the presence of moisture, when under certain conditions weak hydrochloric acid is formed. Our piping material with 3½ per cent nickel is not far enough on the "stainless" side to prevent corrosion. Therefore the mains are to be thoroughly dehydrated before charging with the commercially dry methylene chloride.

VERTICAL AIR DISTRIBUTION

WILLIAM STURM, author of the articles on Vertical Air Distribution in Tall Buildings published in the June and September issues of HPAC, is to be complimented on the very comprehensive analysis he has made of a problem which we know has existed for many years, and on


85-Below-Zero Refrigeration System Being Installed at Kodak Park

Charts Help to Solve LIGHTING PROBLEMS

DO YOU HAVE something to say about any of the articles published this month? An additional comment, or perhaps a question on some point? We follow here the custom of engineering society meetings in allowing a period for discussion following presentation of a paper. You are invited to contribute your views. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

which very little has been done.

This work could be further expanded to include specific recommendations for exfiltration and infiltration air quantities in the calculating of heating loads and selections of heating equipment in tall buildings. Some of this information is in the ASHVE's Heating, Ventilating, Air Conditioning Guide, but could be expanded to a much greater extent from the information contained in Mr. Sturm's articles.

The conclusion one reaches after reading these articles is the necessity for basic design of ventilating and air conditioning systems on a higher pressure basis. This in turn requires specially designed exhaust outlets as well as supply outlets that will not be objectionable from a noise standpoint. The conduit system of supply air distribution for air conditioning systems has satisfied this requirement, yet there is much further work to be done on exhaust systems and general ventilation supply systems.

Mr. Sturm's contribution toward this in the two articles is of considerable magnitude and should be the basis of a more comprehensive analysis by the ASHVE to set up design standards for heating, ventilating, and air conditioning systems. —W. S. Bodinus, Carrier Corp.

CHARTS HELP SOLVE LIGHTING PROBLEMS

I have little comment to offer on the article by E. I. Franks in the September issue, Charts Help to Solve Lighting Problems, since the author states that his data are not to be used for design work and that he finds the chart form easy to use for a rough guide. The graphs apply to only one set of conditions, and applying correction factors in Table 2 assumes the user has available data on utilization and maintenance factors.

We in the lighting business think we have quite a simplified procedure and as accurate as lighting design can be—the data corresponding to the graphs are given in tabular form for a wide range of utilization factors.* The latter are determined for any given installation setup by simple reference just to the room index table and in turn to the utilization factor for any given type of lighting equipment. This seems to me easier to do than to read a railroad timetable, and takes no more time for a "quickie result" than looking up a telephone number.

Mr. Franks gives no clue as to the variables that make up his correction factors. Room size and proportion may affect the result as much as three to one. Colors of ceiling and walls are important with certain types of lighting systems, and the output efficiency of luminaires may differ as much as two to one. All these variables are hard to appraise except by computed data such as given in the tables I mention. That does not mean, however, that simple recipes cannot be developed for lighting all sorts of interiors when assumed conditions eliminate a lot of the variables. —C. E. Weitz, lamp dept., General Electric Co.

*Essential Data for General Lighting Design. Folder D. Lamp Department, General Electric Co., Nela Park Engineering Div., Cleveland, Ohio.

GARDEN AIR CLEANED ELECTRICALLY

Electronics has entered Madison Square Garden, New York, to remove tobacco smoke and clean the air, it was recently announced by General John Reed Kilpatrick, president of the Garden, the Raytheon Mfg. Co. reports. This is being accomplished "by one of the largest installations under one roof in the world of electrostatic precipitators," operated in conjunction with the new air conditioning system in the Garden.

General Kilpatrick said that "It has always been our practice to present the world's greatest sporting events and spectacles. Now our spectators can enjoy these events in greater comfort than that provided in any comparable indoor place of amusement."

The air conditioning system comprises eight individual systems, each handling 67,500 cfm of air. The precipitator installation also comprises eight units, each having 30 cells and ionizers. The cross-section area of each bank of precipitators is 13 x 15 ft. These are installed in the ductwork between the dehumidifiers and the fan, in such a manner that all of the air supplied to the Garden passes through the electronic filters.

Charles S. Leopold, consulting engineer, a member of HPAC's board of consulting and contributing editors, designed the system.

Howard Post, chief engineer of Madison Square Garden, adjusts the power pack which supplies direct current to the electronic air cleaner

QUESTION OF THE MONTH

Keeping Magazine Articles for Future Reference

MANY ENGINEERS and contractors like to keep copies of articles from HPAC and other publications for future reference, and most of them have difficulty in filing them so that it is easy to find the material on a particular subject when the need arises.

Space is always limited, and if the filing scheme is too complicated a lot of the reference value of the material is lost.

In a question on this matter published in the August issue, Reader "R.A.W." said he would be interested in knowing how others solve this problem, and how an engineer or contractor can file engineering information without setting up an elaborate library or file room. Following are some answers to "R.A.W." from other readers.

INDIVIDUAL FOLDERS FOR WORTHWHILE ARTICLES

NOT ENOUGH can be said for the value of such a file. Mine consists of tabbed fiber folders which have metal hooks at the upper ends from which they are suspended in file cases. There is a good sized stack of new ones ready in case a brand new subject comes up.

So when a new issue is ready for filing, I pick up my razor blade together with the specs. What to do with Sam Lewis' August article? Pull out the section on "Air Conditioning — Sheet Metal Work — Air Ducts."

The folders are arranged according to subjects which are marked on their regular metal tabs. Each has a stiff sheet of paper in it at the front and on this are listed cross-index references. With respect to Sam Lewis' article, a note was made under "Chimneys—Steel Stacks," showing in which folder the article may be found.

I even have a folder into which go grievances so I can tell off a manufacturer when the occasion presents itself. The folder on the "Heat Pump" is putting on quite some weight and I am considering dividing it according to the various aspects of the matter.

I wish that the publishers would so arrange these articles that they maybe cut out without sacrificing parts of another good article printed on the reverse side. There should be reprints available of important ones.

Besides this file, I have a library and the file contains many sheets of references to certain books. Then I have a file of manufacturers' catalogs and finally I have a leather ringbound book into which goes engineering information that would come in handy on the job and which can be carried in the head only by a super-engineer.

I love that suspension file. It allows me to reserve judgment until I have gotten in touch with the best brains of the profession.

—W. O.

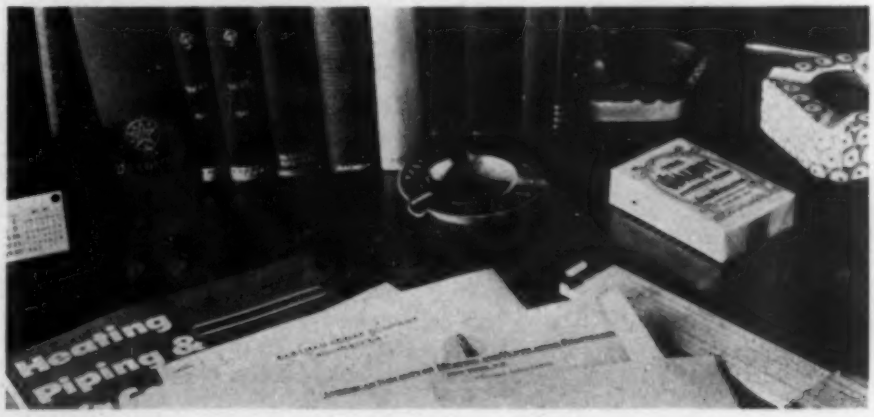
3 x 5 CARDS USED TO INDEX ARTICLES

IN ANSWER TO "R.A.W.'s" question of the month appearing in HPAC for August, I can relate my experience in filing the wealth of material contained in HPAC and other publications in the field of heating and air conditioning.

First of all, I found that the filing of individual articles did not prove to be advisable because oftentimes the article that I wanted to file under one subject contained some part of another article on the back of one or more of the pages of the first article.

Therefore, I have adopted a system using 3x5 cards, each to contain the name of the particular article of interest, authors, name of

Several readers explain their schemes of filing engineering information this month



magazine, date, and sometimes a brief note or two giving some of the highpoints of the article. This same card may also contain any cross-reference that is desired. Then, I have set up a subject file in which the 3x5 card, containing the name of the article and the other information, is placed. Thus, it is obvious that a 3x5 card file is set up by subject, and a card for each article is placed under its particular subject. These 3x5 cards are filed in alphabetical order under their subjects.

As most of the magazines contain many pages of advertisements, I separate the contents of the magazine from all of the advertisements, being careful to retain the table of contents. From here on, it is quite simple then to staple the main body of the magazine together, with the table of contents on the front, and file it in chronological order by month and year. This saves on considerable space and allows all of the worthwhile material to be bound or fastened together in groups of years or however it is desired.

Thus, it may be seen that the 3x5 subject card file serves as an index for the articles contained in the magazines. One advantage of having a card index system is that, over a period of years, it has proved to be quite a time-saver. Not only is it an efficient means of locating articles, but it is an efficient method of filing additional articles on old or new subjects. Another advantage of this simplified method is that it is convenient to maintain the card index in or adjacent to the desk, making it very accessible at all times for ready reference.

January Directory Issue Kept Intact

One more item that I have found to be helpful is that of keeping the January issue of HPAC intact, for reference to the manufacturers of equipment. Then, when the next January issue is received, the old copy is broken down as the other copies have been done.

—R. R.

ASKS FOR HELP ON UNIT HEATING SYSTEM

YOU ARE INVITED to comment on the following question from "J. H." Suitable discussions of this matter will be published, and paid for at regular rates (with additional payment for sketches). Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.

"A building is divided into three distinct heating zones, with different temperature requirements and different rates of heat loss. Each zone is to be heated by a unit heater of suitable size and supplied by steam from a low pressure oil burning steam boiler. Temperatures in each zone are to be separately controlled, no unit heater motor shall run unless there be steam in the heater, the burner shall shut down when all zones are satisfied and shall start when any zone requires heat, and the number, type and cost of control equipment shall be kept at a minimum. I would like suggestions on how best to do this."

TWO DRAWER CABINET DOES THE JOB

THE PROBLEM OF "R.A.W." is interesting because the question of adequate filing for reference data without a large outlay in space or a complicated cross-reference system has long confronted those in the engineering profession. The following method has proved very satisfactory in my case.

I have devoted one small, two drawer, business size filing cabinet exclusively to this purpose. It has adequately filed our articles for a period of three years, with space for approximately two more years.

In making up our files we secured letter size, expanding type, paper wallets. In our case a total of 28 of these has been sufficient. Each wallet was inscribed with a heading as to the classification of material it contained. Our file has four general classes under which all general data of their type are filed. They are Air Conditioning, Heating, Piping, and Refrigeration. The remainder of our wallets are headed by specific headings such as Boilers, Compressors, Condensers, Controls, Furnaces, Heaters, Towers, etc. These headings will depend on the type of business engaged in.

We have found it wise to make an index on the wallet front and as each article is filed it should be listed as to content, name, and author, and given a number as to its position in the wallet. Another good practice is to file an index in each wallet upon which to list names and sources of articles from sources which cannot be clipped out and filed in the usual way.

—W. R. L.

SEES VENTILATION AS WAY TO SAVE SUGAR

Experiments now are under way looking to large savings in sugar, by reduction of the temperature of sugar beets in storage, according to a paper read before the American Society of Mechanical Engineers at its fall meeting in Salt Lake City.

The work is being done at the Colorado Agricultural Experiment Station at Fort Collins, and was described by R. D. Barmington, associate research engineer in charge of the project, at a joint process industries and heat transfer session of the ASME.

Sugar losses in a storage pile vary from ¼ to 1 lb of sugar per ton per day, depending on the temperature of the beet pile, Mr. Barmington said. When 60,000 tons of beets are stored in piles in one average sized factory district, the loss of 1 lb of sugar per ton of beets amounts to a loss of 30 tons of sugar daily. Experiments at this station and elsewhere reveal that a reduction in the pile temperature is the most effective way of reducing the loss.

For best storage of the beets, the temperature must be reduced from about 50 F, the average temperature of the soil at harvest time in Colorado, to as near 32 F as possible without freezing, Mr. Barmington said. For best results it must be reduced as quickly as possible.

One of the means suggested is artificial ventilation of the sugar beet pile using night air which is usually 35 F or lower during the storage season. This method has possibilities, the researcher said.

"It will require further study and experimentation to determine whether or not it would be practical to build structures large enough completely to enclose for controlled ventilation all the beets now stored in the open," Mr. Barmington said.

"In the Fort Collins factory district there are now 60,000 tons of beets piled in the open for a period of 40 to 60 days. If the density is 40 lb per cu ft this would require 3,000,000 cu ft of storage space. To cool these beets quickly for best storage conditions would require a ventilating system having a capacity of 1,200,000 cfm. Further studies and experimenting with properly designed equipment will be necessary to determine whether or not a ventilating system would be economically sound. Large savings in sugar can be made if the temperature of the beet pile can be reduced quickly at the beginning of the storage period."

DATA SHEET

Simplified Procedure for SPECIFICATION WRITING

In the April 1946 Heating, Piping & Air Conditioning there was an article entitled A Simplified Procedure for Specification Writing, by George W. Campbell. Due to several requests, it was decided to run as a supplement to this article a series of specification cards which are currently being used by the firm of Urdahl and Everetts, consulting engineers, in their Washington, D. C., and San Francisco offices. Mr. Campbell is employed in the Washington office.

The cards have been duplicated by the "Ditto" process. After the original duplication on 8½x11 in. paper, the copies were cut into 5x8 in. cards. The "master" ("Ditto" terminology) was also cut out and filed in a 5x8 card file. The original cards have no dates. As the cards were revised, a date was added so that an obsolete card would not be used.

The cards are in two sections, a lettered series and a numbered series.

Let us assume a specific problem. We have designed a direct fired air conditioning system. We would go to the files and remove card No. A. Looking under paragraph 1, we note general intentions, scope of work, and time of bids. These items would be written on a 5x8 in. card or paper and should be given the numbers noted.

Consulting engineers and architects usually have a permanent set of conditions which they use for the particular locality in which they work covering such items as checking, definitions, delays and extensions, and accompanying drawings. These are included in paragraphs 2-31 indicated as printed matter; if we do not want to use 30 paragraphs for this material we can easily change the number.

Paragraph 32, work to be done by others, is another paragraph that will have to be written out for each job as every job will be different.

We now have arrived at the part of the system that is a time-saver. We go through the file and pick out all cards having numbers which are listed on Card No. A, following the title of the specification as direct fired air conditioning unit (1), heat exchanger (9), oil burner (11), etc. In our particular problem we won't need some of the cards. Let's assume we are not responsible for the domestic hot water system, which in this case is a plumbing job; therefore, we return card No. 39 (domestic water heater). Again, let us say the architect is to include in his specification all flashing where it is needed; therefore, we return card No. 34 (flashing).

We now take the cards and number them. Paragraph 33 of our specification will be given to direct fired air conditioning unit (Card No. 1), paragraph 34 to fuel oil tank (Card No. 23), etc. Should any of the cards now become separated, that loss will be easily detected when the secretary starts to type them.

After all the cards have been properly marked for the conditions of the particular job, we turn them over to the typist. After typing, the cards can be stapled together and placed in the job file.

The principal advantage of the system is that the engineer is saved time by not having to write out each specification every time it is desired to specify that item, and it eliminates errors which result from trying to transpose longhand. An added advantage is that an individual specification can be changed by substituting the newly written specification using the old number in place of the obsolete cards.

Several of the cards have been published in the June-September issues inclusive, more appear this month, and others will follow. Because of space limitations, they are shown smaller than the 5x8 in. size. These specifications are not to be construed as recommendations to other consultants but to illustrate this card file used by Urdahl and Everetts.

Card No. 26
Job No. ___

___ DOMESTIC HOT WATER TANK: Furnish and install one ___ ___ gallon hot water storage tank similar and equal to _____. The tank shall be supported as shown on the plans and shall be connected with the hot water heating coil in the boiler with type L hard drawn copper tubing and shall be provided with a three-way flushing valve.

The tank shall be insulated with an insulating jacket of the asbestos cellular type similar and equal to that manufactured by the _____.

Card No. 27
Job No. ___

___ CAST IRON RADIATION: All cast iron radiation shall be of the standing tubular type with 1.75" 2.5" per section for steam hot water radiation. They shall be of the size and in the location as shown on the plans. They shall be similar and equal to those manufactured by the _____ _____.

Card No. 28
Job No. ___

___ CONVECTION TYPE RADIATION: Convector radiators of the size and capacity shown on the plans shall be installed in the exact locations indicated on the plans. The heating element shall consist of copper or brass tubes with extended fins mechanically expanded into place. The element tubes shall have a pitch of 0.25" ___ per foot of tube.

The heater element shall emit 240 ___ Btuh per square foot of EDR for the depths, lengths, and stack heights as noted.

The supply tappings shall be in the end out of the top out of the bottom of the element with the valve riser inside the cabinet outside the cabinet and the return tapping out of the bottom with the fitting (inside) (outside) the cabinet trap (inside) (outside) the cabinet.

Each radiator shall be equipped with an air chamber attached to the enclosure in an accessible position at the discharge end of the element.

The radiator enclosure shall not be less than No. 20 __ gage for the ends and back and 18 gage for the top and fronts.

The cabinets shall be painted inside and out with a gray primer before leaving the factory. Cabinets and enclosures shall be by the same company furnishing the heating elements and shall be in all respects similar and equal to those manufactured by the _____ _____.

The cabinets shall be of the model as shown on the plans.

Card No. 29
Job No. ___

___ STEAM TRAPS: Each radiator, steam main drip, and similar equipment shall be equipped with a thermostatic trap of the required size of straight, angle, or corner pattern, with a rough brass NP body and polished NP trimmings _____.

Each unit heater, steam main drip, and blast heater _____ _____ shall be equipped with a float and thermostatic _____ _____ trap _____ with brass _____ _____ seats and plungers.

All thermostatic elements shall be of the corrugated bellows type, having not less than ten _____ corrugations and a replaceable seat of monel metal or stainless steel _____.

All traps shall be guaranteed to work satisfactorily under steam pressures from a partial vacuum to 10 ___ psig and shall be of the same manufacture and shall be similar and equal to those manufactured by _____ _____.

The thermostatic elements of all traps shall not be installed until the system has been thoroughly cleaned of dirt and scale.

Card No. 30
Job No. ___

___ ASBESTOS CONNECTIONS: The connection between the supply and return ducts and the units shall be made with a joint of 12 oz asbestos cloth of not less than 6" width. The metal shall be 2" apart and the asbestos cloth shall not be stretched so tight that it is under tension.

Card No. 31
Job No. ___

___ SHEET METAL WORK: All ducts shall be constructed as directed and as shown on the plans of _____ as hereinafter specified. Metal seams and reinforcing shall be in accordance with "Table 5 (Recommended Sheet Metal Gages for Rectangular Duct Construction)" from the Heating, Ventilating, Air Conditioning Guide- 1946 published by ASHVE.

All ventilation air louvers exposed to the weather connecting to inside ducts shall be constructed of 16 oz copper and shall be equipped with ¼" mesh copper screening over the openings. All ventilation air louvers exposed to the weather connected to ducts and equipment also exposed to the weather shall be of the same material as the material it is connected to.

Card No. 32
Job No. ___

___ DAMPERS: Dampers shall be arranged for easy access and operation. Damper rods shall be equipped with solid bearings. They shall have adjustable quadrants to show the position of the damper. Where ducts are furred in, these damper quadrants shall be similar and equal to the _____ _____ for adjustment with a screw driver. Dampers shall be of the type indicated on the drawings. Volume dampers shall be 1½ times the width of the duct perpendicular to the axis of the damper. Splitter dampers shall be of the length indicated on the drawings.

Card No. 33
Job No. ___

___ REGISTERS AND GRILLES: The contractor shall furnish and install all supply and return grilles and ceiling diffusers and registers of the sizes shown on the plans. They shall have a prime coat _____ finish.

(winter air conditioning system)

The supply registers shall be similar and equal to model No. ___ ___ and the return grille shall be similar and equal to model No. ___ ____ as manufactured by the _____ _____.

(summer air conditioning system)

The supply grilles and outlets shall be installed with an approved type of volume control and air distributing device and shall be of the type shown on the plans similar or equal to those manufactured by the _____ _____.

The return grilles shall be of the type shown on the plans similar and equal to those manufactured by the _____ _____. They shall have an approved type of volume control.

SAM LEWIS' PAGE

In this regular feature, informal comment on heating, piping and air conditioning matters is given by Samuel R. Lewis, consulting mechanical engineer and member of HPAC's board of consulting and contributing editors. This month he daringly jumps right into the middle of some of the controversies about the subject of radiant heating, giving his views and bringing out the ideas of others as well. Anyone who wants to argue on the matter is invited to join right in.

Let's "Ventilate" These Heating Questions

THERE ARE several interesting problems in heating engineering over which hours of investigation and argument have been spent. The truth eventually will be revealed and prejudice eventually may be quieted. It may be of service if we "ventilate" some of these controversies having to do with radiant heating.

Engineers have agreed fairly well that doing things to the barriers that enclose a room to reduce excessive heat loss from people is a good principle. Carried to its logical conclusion, this principle would be satisfied if the barriers were so effective (as by resistance to heat flow) that the people in the room would furnish sufficient heat for comfort merely by being alive. Radiant heating may be thought of as supplementing the resistance to heat flow of the barriers that enclose a room.

For example, in the early days of radiant heating in the mild climate of England, they used wall panels of masonry or metal having imbedded tubes through which the heating medium was pumped.

Two Schools of Thought

In this country it is not easy to apply the wall panels in sufficient area, and there has been a feeling that wall panels would encourage convection air currents that are believed undesirable. As experience with American radiant heating was gained, there became manifest two great schools of thought concerning the matter—one for warm floors and one for warm ceilings.

While trying to be open minded and unprejudiced, I belong to the ceiling school—my favorite argument being that animals (including people) always have been accustomed to the gentle rays of the sun from overhead, and do not have to rub their heads directly against the warm ceiling. If radiant heat comes from the floors, on the other hand, the animals necessarily must touch the floor with their feet and if the floor is appreciably warmer than the feet, the feet will tell the animal about it. I have met with no trouble jobs whatever, where radiant heat was delivered from overhead, but I have participated in spending considerable sums of money in correcting plants in which radiant heat came through the floor. Control of the heating medium definitely must be far more meticulous for floor heat delivery than for ceiling heat delivery.

If the floor is to do the job, it is probably wiser to imbed the pipes directly in concrete than to pack them in sand or crushed stone below the concrete. It is important that the floor temperature not exceed some very moderate intensity, say 85 deg. Also, the underfloor radiant piping should be designed so that it will vent and drain whether the heating medium is gas (steam) or a liquid (water).

Underfloor System Using Steam

One very large underfloor radiant heating system was designed for steam. It was unsatisfactory because of a too-warm area directly

above each pipe, concerning which the feet complained, and because of too-wide variations in temperature following cycles of opening or closing the steam supply valves. Changing it to water, with the inherent relatively gradual temperature variations, was costly because of air pockets in the buried pipe loops. The original installation, limited to vent and drain with steam, could just as well have been arranged to operate with either steam or hot water.

There are some rooms, of course, that have sloping or vaulted ceilings that are poorly adapted to carry radiant pipes and which therefore may be more easily heated by floor coils. There are occasional rooms that have so great a heat demand as to require radiant energy from both ceiling and floor.

Pipes Above or Below Metal Lath?

If the radiant energy is to be delivered through the ceiling, there is a controversy as to whether the water circulating pipes must be above the metal lath of a suspended ceiling or whether they may be below the metal lath.

The pioneering construction for overhead radiant heating was to assemble and weld and test the coil for each zone or room on the floor, hoisting it in place after such testing. The metal lath of the suspended ceiling then was wired to the pipe coil. Thus, the plaster could be applied with fairly uniform thickness over the entire area of the metal lath, and usually would rise as high as the center of each pipe in the coil above the lath. Insulation usually is installed above the pipes so as to minimize transfer of heat to the floor above the coil, since control of such heat would be difficult.

When copper tubing commenced to compete with ferrous pipe for this application, the tendency was to reduce the diameter of the tubing and to increase its length. The contractor was instructed to install the metal lath in conventional manner and to fasten the copper tubing below it. Thus, the small copper tubes would be well imbedded in plaster, but inevitably the plaster would be very much thicker between the tubes than in the relatively small areas directly below the tubes.

Anxiety is manifested as to whether there will be streaks in the ceilings after a length of time, due to the thin plaster under the tubes in comparison with the thicker plaster between them. It has been rumored that the lathers' union feels that they will be unfairly deprived of work if the metal lath shall be wired directly to and below the pipe coils, since lathers are accustomed to install light rolled channels for supporting the lath. Thus, in strong union circles it may be necessary to install the channels between the radiant heating pipes —merely to keep peace.

Pressure Loss Through the Coils

It is obvious that if, say, ¾ in. internal diameter radiant heating coils are used, the pressure loss and pumping power may be very much less than if the liquid heat carrier is forced through tubing of, say, ⅜ in. outside diameter.

We have ample evidence of corrosion and ultimate leak damage from pipes that carry mixtures of steam, air, and carbon dioxide. We have little evidence of corrosion and leakage from pipes that carry the same water around and around indefinitely, since air and other corrosive gases must be nearly impotent in this case.

There is justification, therefore, for controversy as to whether steel or wrought iron or copper is most desirable in the radiant heating of rooms, and as to whether—when so used—the heat should come from above or below. There may be some interesting experiences reported by next winter with plants in which the tubing is below the metal lath.

My prejudiced practice will be to use any of the metals that seem to me to be expedient in either location that seems to be best suited to the particular job. My friend, the late Samuel Neiler—a great and successful engineer—long ago wrote me a letter expressing exactly this intelligent attitude concerning a similarly controversial issue.

Tells How to Care for Pipe Insulation

Four major steps in an insulation maintenance program were recommended by Utley W. Smith, manager of the Magnesia Insulation Manufacturers Association, to members of the National Association of Power Engineers at their convention in Boston.

Regular inspection is vital to the continuing efficiency of any insulating material, Mr. Smith stated. Maintenance and repair work can be carried out by an insulation contractor on a periodic service arrangement or by the assignment of a permanent maintenance crew if the volume of work warrants. For those charged with supervision of maintenance by a contractor or by their own plant personnel, the following program was recommended for proper maintenance of 85 per cent magnesia insulation:

1) Regular, thorough inspection to assure that all sources of heat loss are insulated.

2) Periodic review of insulation thicknesses to determine whether changes in operations or costs warrant increased thickness.

3) Frequent survey of the protective jacketing on insulation for signs of damage.

4) Examination of the insulation itself for signs of mechanical injury or of loosening caused by excessive vibration, unusual expansion and contraction, or unexpectedly high operating temperatures.

Of particular importance for maintenance are removable covers for flanges, it was stated. Unless these are used, the tendency is to leave flanges uninsulated, an important cause of heat loss. Where expansion and contraction occur, expansion joints are sometimes built into the insulation. And where vibration or other movement makes it difficult to keep insulation in place by conventional means, block insulation may be applied to metal surfaces with the aid of an arc welding gun.

How Infra-Red Radiation Is Used for Space Heating

Cyril Tasker Reviews Two British Reports on Radiant Energy for Process or Comfort

PAPERS PRESENTED in recent months before the British Institution of Heating and Ventilating Engineers, entitled Specific Effects of Infra-Red, and Infra-Red in Relation to Space Heating, contain interesting material for those concerned with radiant heating for industrial purposes and for human comfort. [See vol. 13, no. 129, and vol. 14, no. 138, of the Journal of Institution of Heating and Ventilating Engineers.] A comprehensive bibliography is included and recent advances in the application of "infra-red" are discussed from the heating engineer's point of view.

KEEPING POSTED on heating, ventilating, and air conditioning developments and trends on the other side of the Atlantic is simplified by articles such as this one, wherein Mr. Tasker again reviews some British papers believed to be of particular interest to American engineers and contractors

Follows Laws of Optics

Every substance is capable of radiating infra-red and absorbing radiation, but the capacity varies with the nature and state of aggregation of the material and with the condition of the surface. Infra-red radiation follows the laws of optics.

Most liquids exhibit pronounced absorption lines, and Fig. 1 shows how strongly water absorbs at wave lengths of 3μ and 6μ; the broken line on Fig. 1 indicates how closely transmission through the human skin follows that of water. Studies of absorption spectra may help in the choice of materials and the treatment of surfaces to obtain best results.

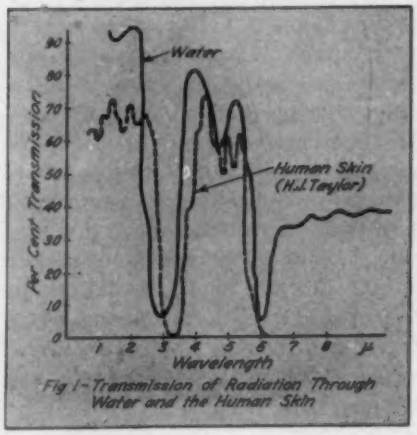


Fig 1—Transmission of Radiation Through Water and the Human Skin

An ideal absorber of radiation is also an ideal emitter and is termed a *black body*. Building materials such as brick, concrete, tile, etc., are fairly effective emitters and approach black body characteristics in the range encountered in space heating. Water vapor and carbon dioxide emit and absorb infra-red radiation only in some sharply-defined wave bands as indicated in Fig. 2.

In space heating by radiation and convection, conditions are usually complex and in a flexible system, radiation being constant, the heat supply can be greatly increased by various rates of convection, but there are few published data to define the ratio of radiation and convection at various rates of air flow over the radiating surface at floor and ceiling levels.

The ratio of radiation to convection in every type of heating system is greatly influenced by the position in which the heating element is fixed. A ceiling panel at 100 F has a radiant output of 80 to 90 per cent; at floor level this is reduced to 20 to 30 per cent, and if exposed to strong draft, is reduced almost to zero. Radiation is very dependent on the character of walls and other surfaces which absorb and re-radiate.

Health and Comfort

In these papers the authors suggest that "a fair density of radiation, evenly distributed, such as may be provided by low and medium temperature radiant ceiling panels, strikes an optimum"; and that "ideal conditions are provided by relatively low air temperatures and relatively high mean radiant temperatures," which impart a feeling

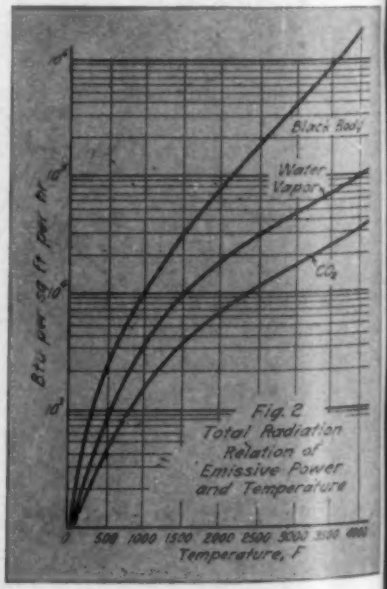


Fig. 2 Total Radiation Relation of Emissive Power and Temperature

of freshness and comfort. It is also suggested that the optimum condition for comfort probably lies around an air temperature of 55 F and a density of radiant flux around 75 Btu per sq ft per hr.

It would seem that in most radiant heating applications in America, air temperatures are but little lower than those found with convection heating or a combination of convection and radiation heating. Greater stress is placed on ventilation needs in space heating in Europe than in America and there is evidently room for increased study of the part played by "freshness" in comfort.

High Temperature Radiation

In these papers it is suggested that "a relatively high density of radiation energy is advantageous" and that "the density of flux of a low temperature radiator panel may be matched with a high temperature (short wave) radiant source by increasing its distance and reducing its area". To quote, "At emission temperatures of 600 F, 1700 F, and 4000 F an equal amount of energy is radiated from surface areas in the relation of 302:19:1, the emission intensities are distributed in a different fashion each time, the high temperature emitter showing a concentration of the short wave bands", see Fig. 3. The radiant temperature as a function of distance is plotted in Fig. 4.

The proportions of radiated and convected heat given off from one patented type of radiant panel fixed in ceiling and wall positions and from column radiators at floor level, are given as follows:

	Radiation	Convection
Ceiling position	80	20
Plane surface, wall position.	56	44
Free standing radiators.....	27	73

Returning to their contention that comfort can be obtained with medium temperature radiation at the correct mounting height in relation to the temperature and with the infra-red rays evenly distributed, the authors report that gas fired suspended radiant heaters, suitable for industrial premises, have been placed on the market in England. They have a luminous refractory radiant at a temperature of 2000 F, and a reflector plate fixed above the radiant at an angle. This acts as a conductor and black emitter, receiving some of the infra-red rays from the radiant and re-directing them to the floor level. The surface temperature of the reflector plate is at 500 F, and the mounting height is 8 ft, 6 in. from floor level.

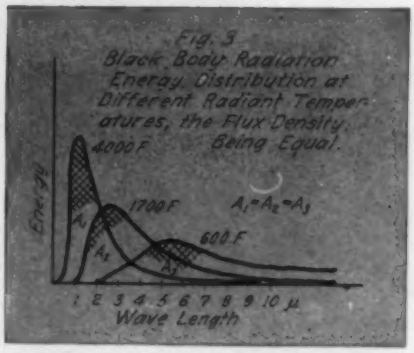


Fig. 3
Black Body Radiation Energy Distribution at Different Radiant Temperatures, the Flux Density Being Equal.
4000 F
1700 F
600 F
$A_1=A_2=A_3$
Energy
1 2 3 4 5 6 7 8 9 10 μ
Wave Length

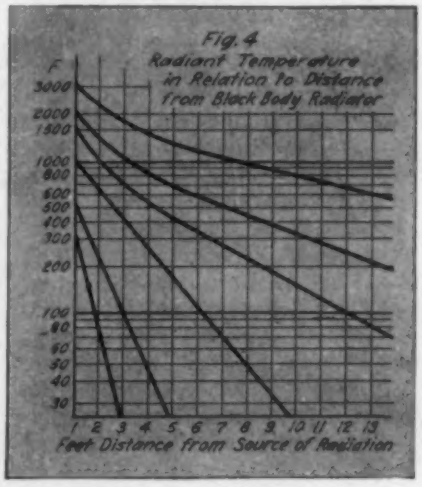
"At 2000 F, peak emission is obtained at a wave length of 2.1μ, with an emissivity of 60,000 Btu per sq ft per hr; and at 500 F, the wave length is 5.4μ with an emissivity of 1400 Btu per sq ft per hr."

Industrial Possibilities

The authors suggest that a really attractive possibility, on which research should concentrate, is the evolution at economic cost of radiant heaters with a high specific emission rate of the wave band around 3μ, since at this wave length water absorbs radiation strongly (see Fig. 1). The practical importance of such a device for drying, evaporating, etc., is stressed; by matching specific emission and specific absorption, instantaneous evaporation of moisture under conditions of high internal efficiency might be effected.

A. H. Barker, in discussing these papers, said that accurate experiments relating to radiant heat are very difficult—"the measurement of the degree of comfort is almost impossible except by prolonged statistical methods". Valid relationships may be derived, however, from a statistical treatment of a sufficiently large number of tests or tested subjects. Mr. Barker said he had designed an instrument which he believed would measure the mean radiant temperature.

It was also suggested that concerted effort by heating engineers and physiologists is needed to determine the most suitable wave length or band of frequencies for infra-red heating of occupied spaces.



Mention was made of modifications of the eupatheoscope and the globe thermometer in which the instruments were split into halves with an insulating partition between them. These modifications proved of value in assessing comfort where radiant heating was from one side only.

Parabolic Reflectors—"Beam" System

It was reported that parabolic or elliptical reflectors had been used to direct heat rays where they were required and that such a reflector with a heating element arranged at the focal point will throw forward rays which are substantially parallel to each other, whereas without the reflector dispersion is considerable, since the intensity of radiation falls off with the square of the distance. This square law does not apply to the intensity of infra-red rays from a parabolic reflector, as they are substantially parallel.

An interesting example of factory heating was mentioned. "On two opposite end-walls radiant heaters are mounted with reflectors in banks: these are designed to throw parallel horizontal rays across the whole length of the factory, but only in the lower region to a height of 6 ft to 10 ft above the floor so that persons in the factory in all positions feel radiant heat coming from two directions, and none of the radiant heat is wasted upon the upper area of the factory. In a factory with an average height of 36 ft, only one-sixth of the total cube of the building need be flooded with radiant rays."

One of the difficulties of this "beam" system, as it is called, is to obtain rays sufficiently parallel to throw the heat over considerable distances while maintaining sufficient intensities. Research work on parallel beams carried on by searchlight designers has assisted in this problem.

"The problem of throwing the radiant heat for distances of 100 ft can be solved providing the diffusion of rays can be kept to a minimum." If all the separate reflectors are mounted at an angle to one another slightly facing inwards so that the diffusion is confined to the width of the factory, most of the heat is conserved in the areas where it is most required.

Gas Radiants

Chemical treatment of the refractories which are heated to incandescence by the flame in gas radiants has resulted in increased radiation emission.

There have been substantial developments in the evolution of overhead radiant gas heaters which have proved advantageous for the heating of factories, assembly halls, churches, etc. They are flueless, have an overall efficiency of 90 per cent, and about half the energy is available in the form of radiation. One type is illustrated in Fig. 5.

Electric heating: Great strides have been made toward the perfection of electrically heated, low-temperature surfaces, produced in the form of reels of double paper, with the resistance wire embedded in the adhesive layer in between. They are usually operated at about 100 F, the current consumption being about 16 watts per sq ft.

Output of Ceiling and Floor Panels

Since there is considerable discussion in America on the output of ceiling and floor radiant panels, the following may be of interest. "By the use of floor panels the practicable range of temperature is limited to 75 to 85 F, but ceiling panels have working temperatures from 80 to 130 F and over, as the height of the rooms and other factors may warrant."

When water of various temperatures was run through the ceiling panel of a 10 ft high room the following thermometer readings were taken when temperatures had become constant:

Water in pipe coil	88	126	164
Ceiling	82	115	147
Air temperature 1 ft from ceiling	64	77	91
Air temperature 1 ft from floor	61	72	82

Thermal Reflection

In these papers the authors suggest that it will eventually be possible to use wall coverings consisting of an insulating board with aluminum foil bonded to the surface and endowed with a decorative paint opaque to the eye and highly transmissive to infra-red. Vast strides had been made during the war in connection with camouflage in the study of the spectral properties of pigments and paints in the infra-red region. The percentage increase in warming due to a reflective coating on insulating board may, however, be rather small.

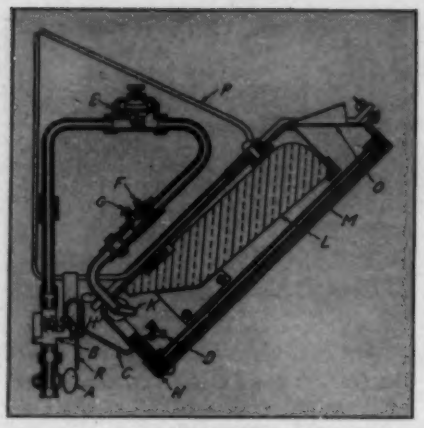


Fig. 5—Overhead radiant heater. A, on-off cock with union. B, cock. C, pilot tube. D, pilot tip. E, governor. F, pressure control screw. G, pressure testing point. H, burner. K, industrial jet. L, refractory brick. M, vitreous enameled front plate. N, chromium plated frame. O, casing. P, wall bracket. R, reflector

The following paragraph from one of these papers strikes a familiar note:

Calculations for Radiant Heating System

"The calculation or estimation of all relevant factors in radiant heating often proves to be lengthy and tedious. There is no dearth of good publications on this subject, but the unifying viewpoint is still missing and also the digest of much of this information in the form of workable tables and charts. It sometimes happens that factors remain unrecognized, such as the effect of secondary convection currents, generated by the action of a radiant heating device. In a system of constant output the radiant effect may be unduly reduced and waste be caused in a flexible one.

"Further progress," the author suggests, "will lie in improvements of testing instruments and interpretation of test results and a refinement of the mathematical treatment. It would be an interesting study to fit a specially designed testing room with every conceivable type of heating device and record all variable factors from the start of the heating-up to the attainment of constancy.

"Such factors may include temperature and thermal characteristics of walls, floor and ceilings; mapping of isothermal lines throughout the room; mapping of convection currents, i.e. velocity and direction; mapping of radiant flux density distribution, direction, and spectral analysis; humidity, ionization and suspended matter (dust)."

ARMY ENGINEER EXPLAINS "PERMAFROST"

Progress in the Army Engineers' battle to conquer "permafrost"—a word coined to describe permanently frozen ground—and to develop design criteria and methods adaptable to far northern construction of airports, roads, underground utilities, buildings, and other types of structures, was reported at the American Society of Civil Engineers annual convention in July.

H. J. Manger, of the U. S. Engineer Office in St. Paul, described permafrost as a thickness of soil or other deposits at a variable depth below the surface of the earth in which a temperature below freezing has existed continuously for a long period of time.

"This phenomenon is quite extensive and covers about one-fifth of all the land area in the world. In the northern hemisphere, permafrost exists in about 80 per cent of Alaska, 50 per cent of Canada, and practically all of Siberia. Its origin is unknown, but it is believed that the phenomenon was formed during the ice age."

Only the Russians, Mr. Manger said, gave much thought to the effect of permafrost on construction prior to World War II, and in the recently-undertaken studies by the U. S. Engineers, much has been gained through the study of Russian literature on the subject.

"In areas where there is danger of settlement by the lowering of the permafrost table, an air space should be provided under heated buildings to prevent heat transfer into the ground," he stated.

WHAT ARE THE FIVE BIGGEST A.C. JOBS?

What are the five largest air conditioning installations in the world?

The Refrigeration Equipment Manufacturers Association is seeking the answer to this question in compiling data on a history of comfort air conditioning.

If you have a candidate for one of the world's biggest installations, send it to REMA, care of Theodore R. Sills & Co., 39 S. LaSalle St., Chicago 3, Ill.

The association also is obtaining material on the first air conditioned stores, beauty shops, funeral parlors, hospitals, factories, theaters, printing plants, photographic studios, and radio stations. "Recognition scrolls" are to be awarded those establishments found to have pioneered air conditioning in their particular fields.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

The Air Conditioning of Processes in the Bread Bakery

By H. R. Gable,* Albion, Mich.

SUMMARY — Twelve separate processes are required to produce a loaf of bread in a period of about 10 hr in a high production bakery where 3000 to 5000 lb of bread are delivered per hour. The different temperature and humidity conditions required in the various processes as well as the presence of carbon dioxide and flour dust cause many problems to arise in the maintenance of equipment. Solutions of the problems encountered are indicated and suggestions are made regarding the possibility of applying complete comfort conditioning to new streamlined bakeries.

THE purpose of this paper is to discuss the air conditioning requirements for the various processes in modern wholesale bread bakeries with emphasis on the specific requirements, problems and equipment features that are peculiar to this application.

The modern wholesale bread bakeries have become high production factories where production often runs as high as 3000 to 5000 lb of bread per hour. As in all modern manufacturing plants product control and production control are extremely important. Competition in the bread industry is keen and because there is very little opportunity for price variation a high quality uniform product is at a premium.

There are 12 separate processes required to produce a loaf of bread and these processes take a total of about 10 hr. There are five separate crews required to handle the various processes. The make-up crew starts its work about 6 hr after the mixing crew has started the day's work. It is about 1½ hr later that the baker starts his day. After another hour and a half the wrapping and slicing crew starts to take over the bread, and finally the delivery crew backs up the trucks to load the bread and start out on a rigidly maintained delivery schedule.

The most important element in bread making is the yeast. The action of the yeast is definitely affected by variations in temperature and inasmuch as these variations may seriously affect the time element in some of the processes, it is necessary to control the temperature. The yeast produces the fermentation action which conditions the dough for baking by converting the starch and the flour to basic sugars and then breaking these sugars down into carbon dioxide and alcohol. The carbon dioxide causes the dough to rise and become light and plays an important part in developing a fine texture in the finished bread. The alcohol assists in developing the flavor. This fermentation action is going on from the time the ingredients are mixed until the yeast action is finally killed in the oven.

In the earlier bakeries temperature control was either absent or haphazard. Many bakeries, especially the smaller ones, are operated in the same way today. The result is that the various processes vary from day to day depending on the weather conditions. This causes great variation in both the quality of the product and its availability to the customer. Air conditioning and refrigeration play a large part in securing uniformity of fermentation action which in turn produces the uniform results required in present day modern plants. In addition to the processes during which fermentation is taking place there is

*Engineering Department, Union Steel Products Co.

also the flour storage, make-up water preparation, baking and bread cooling where air conditioning and refrigeration can play an important part.

To understand the requirements for successfully air conditioning the various processes it is necessary to understand the relation of these processes to each other and the effect of ambient conditions on the product at various stages of development.

Flour Storage

The flour storage represents the first process in making bread because it is in the storage that the flour is aged. As indicated in THE GUIDE conditions of 65 to 75 F and 55 to 65 per cent relative humidity are desirable for proper aging and preservation of the flour. To maintain these conditions throughout the year air conditioning is definitely required. However, the majority of the plants today depend on cool locations and air circulation to prevent excessive deterioration. There appears to be increasing interest evidenced in the air conditioning of the flour storage and this interest is especially noticeable in Canadian bakeries.

Mixing

The mixing of the ingredients to produce the dough is the second process. In the mixer, due to a heat generation problem, caused by both chemical action and friction between the dough and the mixer wall, means for heat dissipation is required. This is partially accomplished by refrigeration of the liquids, namely the water and milk, and by use of heat absorbing means, such as cracked ice for part of the water requirement or a cooling jacket around the bowl of the mixer. In the cooling jacket refrigerated water, of about 33 F, is most commonly used, but recently direct expansion of a refrigerant has become increasingly popular. The introduction of conditioned air directly into the mixer bowl has also been tried successfully but has not been used very generally.

Bulk Fermentation

There are two general methods for preparing the dough for fermentation. They are the straight-dough process and the sponge-dough process. In the first, all of the ingredients are mixed at once. In the second, part of the flour and water and all of the yeast and yeast food are first mixed into a batter called a sponge. This sponge is allowed to ferment for a considerable time. The sponge is then returned to the mixer and the remainder of the flour, water, sugar, salt, malt extract, powdered milk, and shortening are added for a final mixing.

Fig. 1—Exterior view of fermentation room in modern large bakery

The latter method is the most widely used in the large production bakeries because it produces the pure white, fine grained, soft loaf that is so much decried and yet so eagerly purchased.

The principal advantage of the sponge-dough process lies in the fact that the salt, which has a retarding action on the yeast ferment, is absent. This allows the ferment to work freely on the fermentative material of the flour and yeast food.

The sponge is taken out of the mixer at a temperature between 76 and 78 F and placed in a *trough*. This is a large steel tub holding 600 to 800 lb of sponge. As the sponge comes out of the mixer it has a density of about 110 lb per cubic foot. At the end of the bulk fermentation period the density will be around 12 to 15 lb per cubic foot.

The bulk fermentation process is the first of three processes where the advantages of air conditioning are pretty well recognized. The effect of temperature variations on the action of the yeast and the effect of relative humidity on the rate of evaporation from the surface of the sponge makes the control of the air conditions surrounding the fermenting sponge desirable from both the product and production control standpoint.

During this fermentation period the yeast is very active and the production of heat from the chemical action raises the temperature of the sponge mass from 6 to 8 deg. In the earlier days of baking wooden troughs were used and afforded some degree of insulation and held the heat in the sponge. Later, steel troughs were substituted for reasons of sanitation and upkeep. With the introduction of steel troughs the transfer of heat between the sponge and the air, when there was a marked difference in temperature, produced a temperature gradient between the center of the sponge and the outer surface that meant a graded action of the yeast ferment and non-uniform fermentation. Maintenance of the ambient temperature at 80 deg makes it possible to maintain a substantially uniform temperature throughout the sponge.

Water, being a major portion of the sponge, will evaporate rapidly into the low humidity air. Rapid evaporation from the surface produces a crust that results in the streaks sometimes found in the finished bread when folded into the dough. A 75 per cent relative humidity at 80 F dry bulb controls the evaporation sufficiently to produce the right dough surface if the air turbulence over the surface does not exceed 5 ft per min.

These conditions of 80 F dry bulb, 75 per cent relative humidity, and very low air turbulence at the surface of the doughs are the requirements to be met in air conditioning the space where bulk fermentation takes place. To secure these conditions an insulated enclosure independent of the mixing area is usually constructed. This enclosure, usually with an 8 ft ceiling height may house 20 to 30 troughs as the fermentation period for sponges runs from 4½ to 5 hr and there are 3 to 4 sponges produced per hour per mixer. Because of the high dew point maintained within the en-

Fig. 2—Interior view of fermentation room in modern large bakery

closure it must be well insulated to prevent condensation on the inside surfaces and, equally important, must have a moisture barrier. When outside building walls are made a part of the enclosure the equivalent of 3 to 4 in. of cork is required. For inside or partition walls the equivalent of 1 in. of cork is usually satisfactory. For moisture barriers only metal or vitreous tile have proved to be entirely satisfactory. Where concrete plaster is applied directly over cork the plaster becomes moist enough to support mold growth and a very unsatisfactory situation develops. Most modern bakeries today use prefabricated rooms of panel construction on a steel frame. The panels, 3½ to 4 ft wide by 8 ft long, consist of 1 in. wood fiber core with 24 gage galvanized steel sheets bonded to each face with a waterproof glue. The panels are then finished with baked white enamel to produce an easily cleaned surface. It is interesting to note that it is not necessary to seal the edges of the panels as at 71 F dew point the vapor pressure is not great enough to cause moisture penetration into the end of the panel for any distance. Figs. 1 and 2 show fermentation rooms in a large modern bakery.

The air conditioning unit must be entirely of copper and brass construction because of the carbon dioxide in the air. The carbonic acid that is formed is highly corrosive to zinc and in the presence of carbonic acid the electrolytic action between copper and zinc is especially destructive. It was also early discovered that aluminum fin, copper tube heating and cooling coils were unsatisfactory as the aluminum tends to disintegrate rather rapidly. Some heating coils are used with cast iron headers and the cast iron is definitely attacked but the thickness of the castings usually provides a satisfactory life span.

Flour dust, which fills the air in a bakery, is a constant source of trouble and continually fouls the conditioning equipment if regular and thorough cleaning is not adhered to. It is usually necessary to scrub the unit down thoroughly at least once a week and sweeten the system with a hypochlorite of soda solution. Where the flour and dust are allowed to form a sludge and remain for any length of time, micro-organisms that attack the metal will develop. Resistance filters are useless in the air system of equipment in a bakery as they become clogged almost immediately. There is undoubtedly a fertile field here for the electronic precipitation type of filter as flour dust is a serious problem throughout the bakery.

The air distribution system in the fermentation room is of exceptional importance as it is necessary to handle sufficient air volume to pick up the sensible heat load during periods of high outside dry bulb temperature conditions without producing too great an air turbulence over the dough surface. There is practically no latent heat load because of the high dew point temperature maintained within the enclosure. This means that the allowable dry bulb temperature rise is limited to approximately 9 deg which makes it necessary to handle a considerable volume of air to pick up the midsummer heat load.

The history of fermentation room air conditioning development shows a constant wrestling with the problem of more efficient introduction of air into the enclosure. Every improvement in air discharge equipment that has been developed has been eagerly adopted and efforts have been made to adapt it to this problem. Definite improvements have been secured but the requirements are so rigid that there are still peak heat load periods in certain localities where it is difficult to maintain the conditions required. Consequently, the search continues for improved methods.

The possible solutions to this problem are limited in application, one for economic reasons and the other for sanitary reasons. The first solution is, of course, sufficient insulation to reduce the heat load materially. However, the amount of insulation that would be required to make it possible to maintain absolutely uniform temperatures throughout the year are not economically feasible in the majority of bread plants. The second solution would be the creation of a latent heat load by the introduction of moisture into the room independently. This method has been used successfully but does not have general acceptance because of the moisture condensation problem that exists with the introduction of the free moisture into the air. This is exactly what the bakers were trying to get away from when they adopted conditioned air equipment.

Re-Mixing and Floor Fermentation

At the completion of the sponge fermentation the sponge is returned to the mixer and the remainder of the ingredients are added for final mixing. Then the finished dough is taken from the mixer at a temperature of about 80 F and left in the trough for a second short fermentation or rest period. This period lasts for 20 to 30 min for the purpose of generating more carbon dioxide to lighten the dough again after its beating in the mixer. In some plants this dough is returned to the conditioned room for this second fermentation period but in the majority of the plants the troughs are just left on the floor in the open bakery.

Loaf Make-Up

The dough is then placed in the hopper of a machine called the divider which divides the bulk dough into pieces of a given weight. These dough pieces are then rolled into balls in a machine called the rounder and sprinkled with flour to control the surface evaporation.

The dough balls are then placed on canvas, wood or stainless steel trays in the intermediate or overhead proofer. This is another fer-

mentation period for the purpose of regaining the lightness lost during the operations of dividing and rounding.

The trays are moved through an enclosure placed near the ceiling where the benefits of the warmest location in the bakery can be utilized in aiding the fermentation. This proofing or fermentation period lasts about 30 min and in only a very few bakeries has any attempt ever been made to maintain temperature and humidity conditions. There is a growing speculation on the advisability of conditioning this enclosure but it has not been definitely established that there is sufficient value to be gained from this extra conditioning equipment.

As the dough balls leave the intermediate proofer they enter the moulding machine which forms them into elongated rolls to fit the bread pans. These rolls are then placed in pans on racks and are moved into the final proofing cabinet. It is in this process that air conditioning is most widely recognized as a requirement. A 16 rack proofing cabinet is shown in Fig. 3.

The conditions required in the final proofing cabinet are given as 90 to 95 F and 80 to 90 per cent relative humidity in THE GUIDE. There may be a few bakeries where bread is proofed at 90 F but in a great majority of bakeries proofing temperatures of 95 to a high of 120 F are required. This variation in requirements is due to variations in formulas and flour characteristics. In some cases the higher proofing temperatures are used to speed up the proofing but the majority of large operators are tending to go to the higher temperatures without reducing proofing time.

The average proofing time is 60 min but this will vary, with different operators, from 40 to 90 min. Relative humidities are usually in the range of 80 to 90 per cent. There is some tendency for those operators who maintain temperatures around 95 to 98 F to try to maintain 95 or 96 per cent relative humidity. It is apparent that there is no uniformity of opinion concerning final proofing condition requirements.

The necessity for the relatively high temperatures and humidities is understandable when consideration is given to the fact that the yeast has pretty well completed its action and requires a high temperature condition to produce the final rise required. The individual loaves also expose a great deal more surface than was true during bulk fermentation and consequently higher humidities are required to control the evaporation.

Originally the baker tried to secure the temperature and humidity conditions he required by injecting live steam into the proofing cabinet. As this produced very unsanitary and uncontrollable conditions, it was in the proofing cabinet that bakers first turned to air conditioning for a solution to their problem.

The principal problem encountered in conditioning the proofing cabinets is the matter of maintaining sufficiently high surface temperatures inside the room to prevent condensation or moisture. The majority of proofing cabinets are of prefabricated insulated panel construction somewhat similar to the fermentation room already described with the exception that the problem of surface temperature is somewhat more exacting. One inch thick, wood fiber panels have proved satisfactory with dew point temperature inside the cabinet up to 92 F. However, with the trend toward higher proofing temperatures and resultant higher dew point temperatures, the possibility of trouble may be anticipated when bakery temperatures are as low as 65 to 70 F.

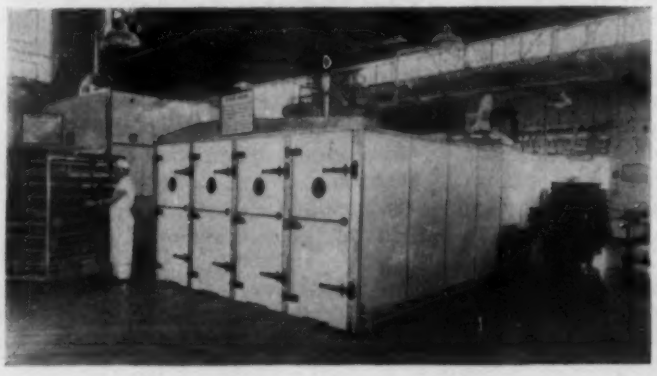


Fig. 3—Sixteen-rack proofing cabinet

After the ovens have been in operation for some time the average bakery temperature is in the neighborhood of 80 to 85 F or even higher during summer months but at the beginning of the proofing operation bakery temperatures may be sufficiently low for a period to cause some condensation trouble.

In addition to using moisture barriers on the face of the insulation it is necessary to seal the edges against moisture penetration. It is also necessary to avoid all metallic contact between the inside and outside surfaces of the cabinet as condensation not only promotes mold development at these high temperatures but also with the carbon dioxide in the air, deterioration of the metal is rather rapid.

The air conditioning units are substantially the same in construction as those used in the fermentation room except for the fact that cooling is rarely if ever needed. Occasionally in southern climates bakery temperatures will exceed 100 F and evaporative cooling is used to retain the cabinet temperatures. The usual design of unit controls the wet bulb temperatures by direct injection of steam into the air stream within the unit and saturation of the air by means of a recirculating spray. A reheater coil then produces the finally desired condition.

The ductwork outside of the proofing cabinet is subjected to corrosive factors when there is condensation within the duct and, rather than insulate these ducts, they are usually constructed of aluminum and coated inside with a waterproof lacquer.

Baking

At the end of the final proofing period the bread is ready for the oven where, with a temperature around 450 deg, the bread is baked in about 30 min.

In addition to temperature control some humidification is required in the oven as the presence of moisture in the air during the baking tends to develop a less brittle crust. The actual effect of super-heated moisture in air at a temperature above 212 deg is not completely understood but the deposition of moisture on the surface of the dough before the dough has had a chance to reach a temperature of 212 deg has the effect of caramelizing the sugar at the surface producing the rich golden brown crust. To accomplish this a perforated steam pipe is run across the oven in such a posi-

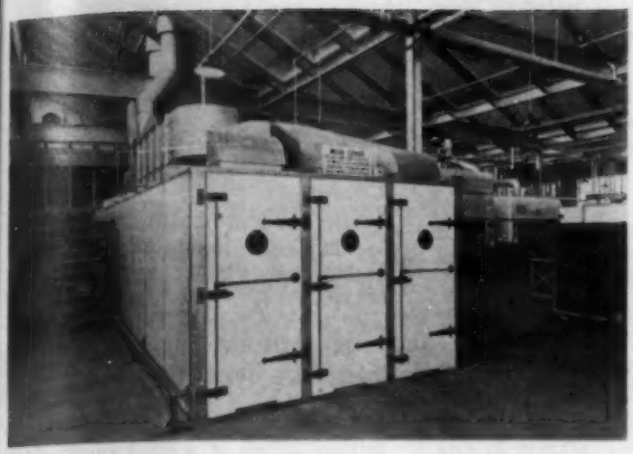


Fig. 4—Bread cooler in modern large bakery

tion as to cause live steam to be showered on the loaves just after they enter the oven.

Loaf Cooling

While the crust temperature may rise to the baking temperature the internal loaf temperature never exceeds the boiling point of water and consequently comes out of the oven at 212 F. For slicing and wrapping the internal temperature of the loaf must be in the neighborhood of 90 F in order that the vapor pressure within the loaf will be sufficiently low to prevent condensation inside the wrapper, with the resultant mold development when mold spores are present.

When the bread leaves the oven the vapor pressure within the loaf is sufficiently high to cause flash evaporation in ordinary room atmosphere. The evaporation of this moisture from the bread contributes to the cooling of the bread along with normal conductance of heat to the cooler air.

The rate of evaporation and consequently the rate of evaporative cooling together with the rate of conductive cooling will vary with the air condition surrounding the loaf during the cooling period. This means a great variation in cooling time from day to day and a great variation in final moisture content.

The smaller bakeries do not have sufficiently rigid schedules, in many cases, to feel that controlled cooling is necessary. However, in the larger bakeries where production and delivery schedules are important air conditioning is used to insure uniform cooling time and good keeping qualities for the bread. A bread cooler in a large modern bakery is shown in Fig. 4. The interior view of a large Mexico City bakery in Fig. 5 shows both bread proofing and cooling cabinets.

The HEATING, VENTILATING, AIR CONDITIONING GUIDE 1947 specifies a temperature of 70 F and 60 to 70 per cent relative humidity for loaf cooling. This would appear to indicate a uniform temperature condition throughout the cooling room. However, in a continuous process of this type, where the heat load is principally from the product, a counter-flow method of cooling, where the air moves in one direction through a tunnel-like enclosure while the racks of cooling bread move in the opposite direction, produces much more satisfactory results.

Hot bread when exposed to a temperature that is too low tends to collapse, producing a cracked crust and generally crippled appearance. Also when the hot bread is subjected to a low temperature and high humidity condition, a soggy undercrust condition will develop. Therefore, the use of a counter-flow system not only produces the most effective mean temperature difference but also subjects the bread to varying air conditions through different stages of its cooling. This proves very beneficial to the final appearance of the bread.

Air is usually introduced into the cooling tunnel at a temperature of 76 to 80 F with about an 80 to 85 per cent relative humidity. This air comes in contact with the bread approaching the 90 F internal temperature and all of the cooling during this latter phase occurs by conduction with excess evaporation under control. As the air moves along over increasingly hotter bread, its temperature rises until at the bread entering end of the tunnel the air temperature is in the neighborhood of 100 F with a relative humidity in the neighborhood of 50 to 60 per cent. This air of higher temperature is sufficient to prevent cooling shock and the lower relative humidity permits initial evaporative cooling and removal of excess moisture.

Cooling time under these conditions is maintained at 90 min for 1½ lb loaves of bread. The quantity of air required to be handled through this type of cooling tunnel is considerable and approximates 1¾ cfm per pound of bread cooled per hour. The equipment for cooling the air usually employs evaporative cooling, with air being brought in through a stack from the outside, passed through a double bank of sprays and then introduced into one end of the cooling tunnel. The air, as it leaves the opposite end of the tunnel, is then exhausted to the outside, with the aid of an exhaust fan that creates a slightly low pressure in the tunnel to insure the uniform air flow, without recirculating eddies, through the entire length of the tunnel.

An air mixing damper section is usually employed connecting the two outside air stacks with the return air duct and unit to allow recirculation of a portion of the air during cold weather to maintain the wet bulb temperature and prevent

Fig. 5—View of proofing cabinet (right) and bread cooling cabinet (left) in Mexico City bakery

the temperature of the air entering the tunnel from dropping below 76 F.

With this type of system no effort is made to control the upper limit of the air temperature which at all times will be approximately three to four deg above the outside wet bulb temperature. In some systems the introduction of cold water into the spray system is employed to hold wet bulb temperatures down during periods of excessive outside wet bulb conditions and in a few cases refrigeration has been employed. However, with the amount of air being handled and the comparatively short duration of periods when the wet bulb will exceed 78 F in most parts of the country, it is questionable whether the amount of cooling medium required is economically justified.

Wrapping Room and General Bakery Condition

At the end of the cooling period the bread is sliced and wrapped and loaded into trucks for distribution.

Some attempt has been made to condition the slicing and wrapping room but this has not proved too popular to date partially because of the maintenance problem caused by the amount of wax evaporated into the air by the sealers on the bread wrappers.

Many bakery architects are seriously considering the air conditioning of the complete bakery but the main problem to be solved, before this can be done generally, is to isolate the large heat producers such as the oven and mixers. A good deal of thought is being given to this problem and within the not too distant future new streamlined bakeries will be able to maintain comfort conditions economically throughout the greater part of the bakery.

Conclusion

Because of the effect of temperature on the activity of yeast, air conditioning is desirable during the various fermentation periods through which the developing dough passes if uniformity of product and production is to be secured.

The bulk fermentation and final proofing period are quite generally recognized as processes where air conditioning is definitely required and most progressive bakeries are employing air conditioning equipment for maintenance of required conditions.

Bread cooling is the only other process at the present time where air conditioning is in fairly common use.

There are several other processes in the bakery where control of air conditions might possibly contribute to improved products and general operation if use of the additional equipment could prove to be economically satisfactory.

Complete comfort conditioning for the bakery plant outside of the process rooms would have many definite advantages and is being increasingly considered by bakery architects.

ASHVE MEMBERS BECOME FELLOWS IN *ASRE*

The Council of The *American Society of Refrigerating Engineers* has recently elected to the new grade of *Fellow in the ASRE*, a small group of eligible members. To qualify for this grade an applicant must be an *ASRE* member for at least 10 years and meet not less than five of a special list of qualifications. Among the ASHVE members honored by fellowships are: W. L. Fleisher, past president and life member of the ASHVE and president of Air and Refrigeration Corp., New York, N. Y.; Harold M. Hendrickson, air conditioning engineer, San Francisco, Calif.; B. H. Jennings, professor of mechanical engineering, Northwestern University, Evanston, Ill.; and C. S. Leopold, president of the *ASRE* in 1946 and consulting engineer, Philadelphia, Pa.

NDHA PROCEEDINGS PUBLISHED

The 1946 Proceedings of the *National District Heating Association* are now available in Vol. XXXVII now being distributed by the Association. The present volume of 222 pages contains papers and discussions forming the reports of the technical committees as follows:

Commercial Relations (Utilization)
Distribution
Educational
Insurance
Meters and Accessories
Operating Statistics
Rates and Regulations
Research
Sales Development
Steam Station Engineering

The book is obtainable from the Association's headquarters, 327 N. Euclid Ave., Pittsburgh, 6, Pa.

T. N. ADLAM WRITES RADIANT HEATING TEXT

Radiant Heating, by T. Napier Adlam: This is a book on Radiant Heating, which includes also a chapter on Radiant Cooling and Snow Melting.

The author draws upon his 30 years of experience in the design of radiant and panel heating installations in Europe and America.

Fundamentals are covered in chapters on Theory of Heat Radiation, Artificial Heating as Related to Body Heat Losses, Measurement of Comfort, Mean Radiant Temperature, and Temperature Studies.

Practical design, fabrication and installation of coils are illustrated in chapters on Ceiling Panels and Floor Panels. Both chapters contain illustrations showing construction of panels and their appearance when being installed on the job or in process of construction. Air venting requirements, piping systems, distribution of water and control arrangements are described and illustrated.

Determination of panel temperatures and the design of panels and coils are treated in chapters on Areas and Surface Temperatures and Pipe Size, Spacing and Heat Input. The author discusses the effect of various types of commercial floor coverings upon the heat output of panels and reports results of tests determining output and surface temperatures.

In the chapter on Radiant Cooling the author describes results obtained in an installation designed for radiant cooling in connection with dehumidification. Snow melting applications of coils, in which an antifreeze solution is circulated, are illustrated for various types of installations.

Final chapters illustrate the author's step-by-step procedure for Radiant Heating Design. Sixty-four charts simplify the coil and panel design for typical construction with conventional floor coverings.

Clothbound, 6 x 9 in. Published by Industrial Press, New York, N. Y.

Air Temperature Gradients in a Panel Heated Room†

By J. M. Ayres* and B. W. Levy,** Lafayette, Ind.

SUMMARY—A report of temperature gradient measurements taken in the living room of a test house heated by warm water panels. The panels were located in ceiling, floor and both outside and inside walls thereby permitting the operation of panels in any desired location. Floor panels produced the most uniform temperature gradients, ceiling panels the greatest variation and wall panels an approximate mean of the gradients observed for floor and ceiling panel operation.

THE development of radiant panel heating has greatly increased the interest in the floor to ceiling air temperature gradients in a panel heated room. A survey of the literature has disclosed a number of articles in which temperature gradients are described, but none in which substantiating data, taken under precisely-controlled operating conditions, are included. The present investigation was made, therefore, in order to provide accurate, fully documented data on air temperature gradients as a function of load and of panel position (such as floor, wall, or ceiling).

The data for this paper were obtained in the five room residential-type panel heating and cooling laboratory located on the Housing Research Campus of Purdue University. This house has been fully described in an earlier publication[1]; consequently, only equipment utilized in these tests will be discussed. A winter view of the building is shown in Fig. 1.

Test Procedure

All of the tests were performed in the living room which is in the southeast corner of the house. A control system was employed wherein return water from the panels was blended with a fixed temperature boiler water to obtain the desired supply water temperature. A three-way mixing valve was actuated by a temperature sensitive element located in the discharge, and having its setting reset, through relays, by a modulating room thermostat. The thermostat was located in the test room at the five foot air level and is visible at the right of Fig. 2. Previous investigations demonstrated that this control system was the most effective for maintaining constant room air temperatures.

In view of the difficulty of measuring air infiltration rates, it was decided to introduce outside air positively into the room and allow it to escape through one unsealed door. A constant speed fan was enclosed in an aluminum painted box, and the flow rate was adjusted by positioning the damper, shown in Fig. 3. A five inch diameter galvanized iron duct channelled air to a plenum chamber, and from there it was introduced into the test room through a grille. The three-ply wooden plenum is visible at the right of Fig. 3.

The apparatus used to measure the air temperature gradients is shown in Fig. 2. It consisted primarily of a stand (extending from floor to ceiling) on which were located a series of fourteen, copper-constantan thermocouples. Stiff wires were attached to the stand, and the thermocouples were mounted along these in such a way as to allow the actual thermocouple junction to project freely into the air at each point. In order to measure steeper gradients near the floor and ceiling,

Fig. 1—Exterior view of test house southeast corner view

†A report resulting from a research project on panel heating being conducted at Purdue University under a grant from the *Copper and Brass Research Association;* this paper was prepared in cooperation with the Housing Research Foundation: G. Stanley Meikle, research director; Carl F. Boester, housing executive.

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[1]Response and Lag in the Control of Panel Heating Systems, by F. W. Hutchinson (ASHVE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, February 1947, p. 111).

thermocouples were placed along the stand with greater frequency near these surfaces than near the midway point. The first and last of these fourteen thermocouples were located an inch below the ceiling and above the floor, respectively. In addition to these, at the floor and ceiling one thermocouple was placed directly on the surface and covered with masking tape while another was fixed with the junction 1/16 in. off the surface. In order to protect these latter two thermocouples from radiation, they were placed over a square of bright, metallic foil-covered paper which was taped to the surface, the reflecting side away from the thermocouple junctions. Similarly, to protect the remaining air thermocouples against radiation from the warm panels, small shields of foil covered paper were affixed to the stiff wires so as to cover the thermocouples on one side. These radiation shields were attached in a manner which would allow them to be turned in order to protect the thermocouples from whichever panel might be in use. All the thermocouple leads terminated at a master thermocouple board in the control room. A small section of this board, in addition to the two sixteen-point, electronic recording potentiometers used, and an outside air temperature recorder, may be seen in Fig. 4.

Upon consideration of the possible variables which could affect the air temperature gradients, it was assumed that the gradient depended on the heating load, the location of the panel, and the ventilation rate. Since the control system previously described operated to maintain an essentially constant inside temperature at all loads, the heating load was a function, primarily, of outside temperature. The panel used for heating was a matter of choice since ceiling, floor, exterior wall, and interior partition panels were available. It was decided to maintain a fixed ventilation rate of 1.4 air changes per hour and to measure the gradients with each of three outside temperatures in a total of twelve tests. The tests were run as closely as possible to outside temperatures of 15 F, 30 F, and 45 F, corresponding respectively to a rather heavy, moderate, and light load for the locality. Due to a mechanical difficulty with the gas pilot on the boiler, a temporary shutdown occurred during part of the heavy load period of the heating season. This prevented the test run for the floor panel at the 15 F condition.

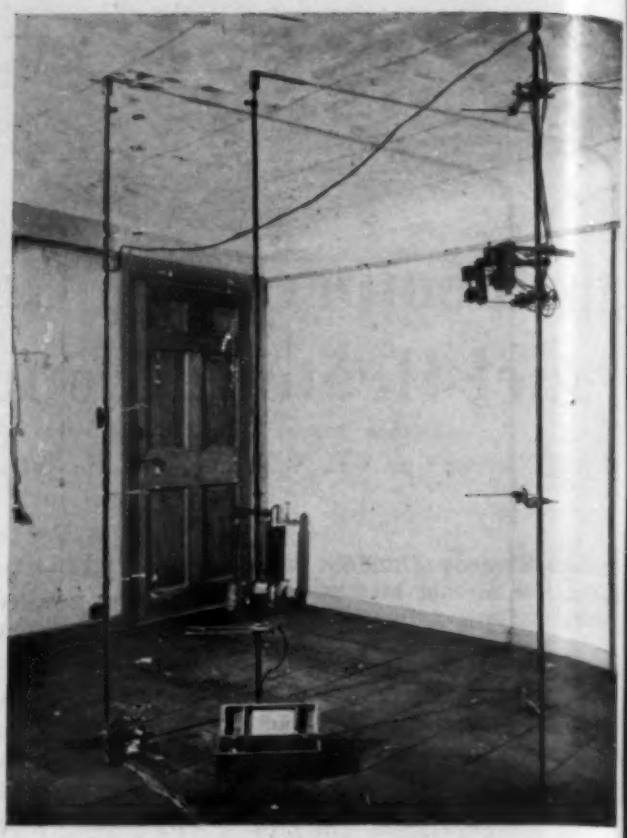

Fig. 2—Interior view showing testing apparatus

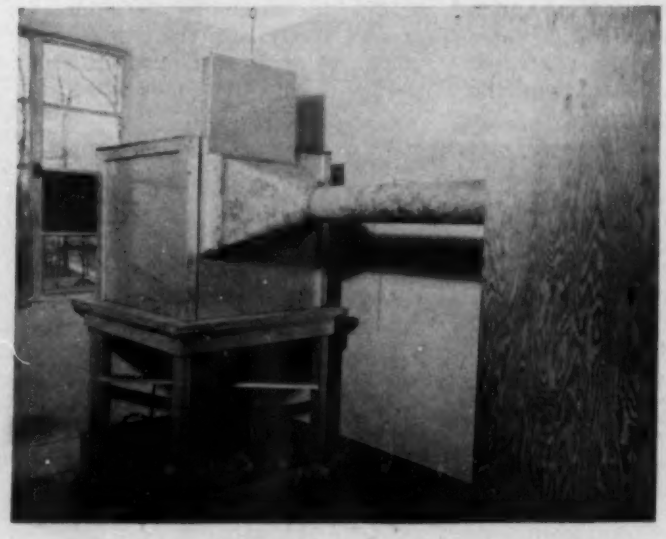

Fig. 3—Air supply fan

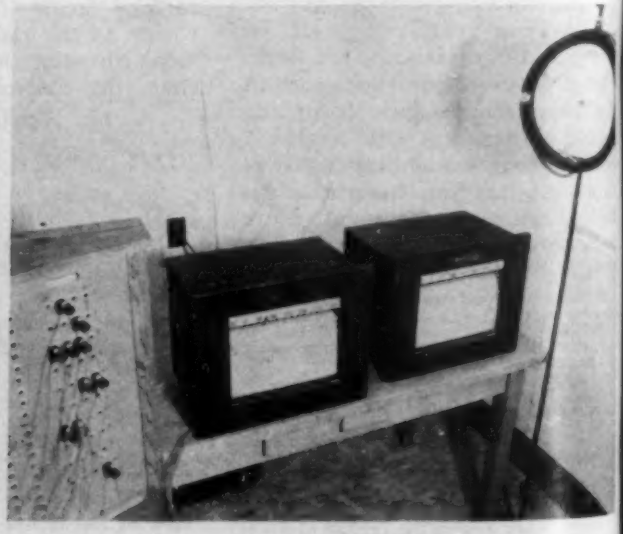

Fig. 4—Thermocouple terminal board and recorders in control room

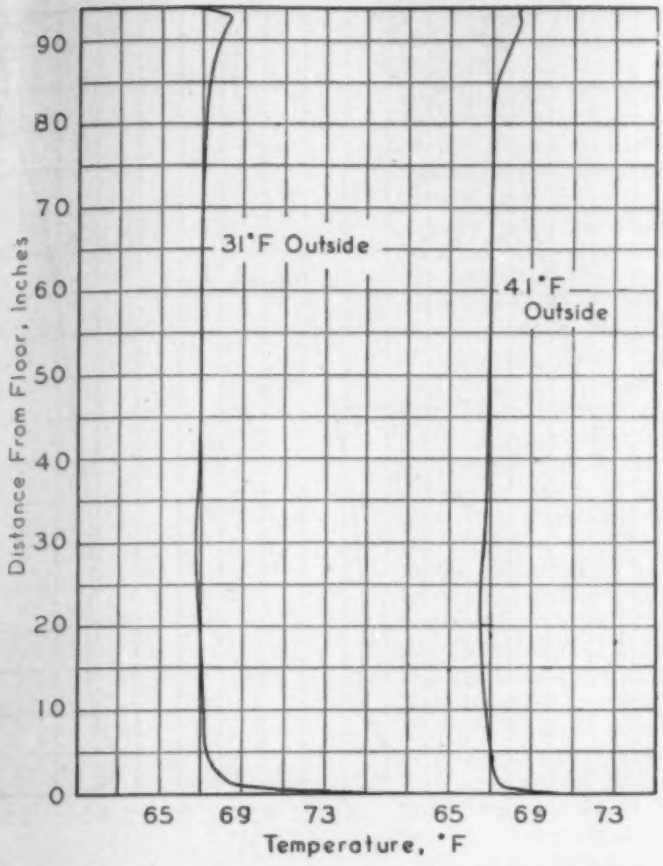

Fig. 5—Air temperature gradients—floor panel heating

All other factors affecting the operation of the panels were maintained constant during all tests. The boiler water temperature was maintained at 140 F, and the water flow through the panel in use was set at one gallon per minute. One of the flow meters used to set the flow, in this case for the floor panel, may be seen in the center of Fig. 2.

To assure equilibrium, the panel to be used was put into operation and fixed test conditions set at least twenty four hours prior to the time data were recorded. A continuous record by means of potentiometers was then obtained to show the air gradient temperatures as well as other pertinent temperatures such as outside temperature, various water temperatures in the system, and the temperature of the air entering the room. Each temperature was recorded once every four minutes.

Preliminary investigations revealed that solar radiation distorted the gradients during the day and early evening. In order to avoid this effect completely, data were always

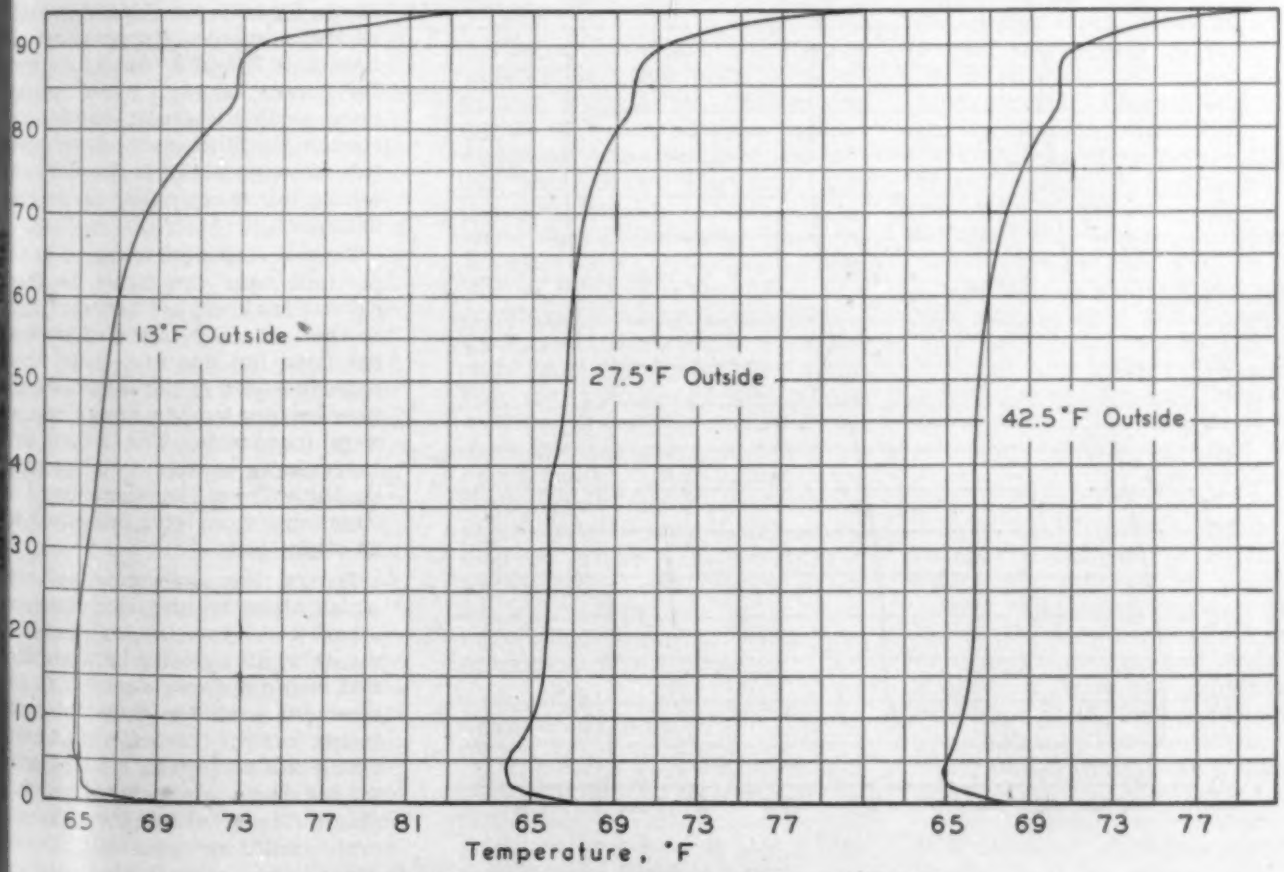

Fig. 6—Air temperature gradients—ceiling panel heating

taken (from the continuous records) during the early morning hours such as 3 to 5 a.m. These hours usually included the periods of the most constant (and lowest) outside temperatures so that perfect equilibrium was very nearly approached. In all cases, two sets of temperature data were taken from the charts, and in most cases the complete forty eight hour test was duplicated at least once, in order to substantiate the results presented herein.

Even though the room thermostat was set at 67 F, control was often maintained at a slightly higher temperature. Since these tests are not particularly concerned with accurate control, this deviation was unimportant, and when plotted, all temperatures were shifted sufficiently to place the five foot level temperature at 67 F in each case.

Test Data Plotted

The data for all tests were taken as described, and resulting temperatures were plotted against height from the floor. The curves are shown for each panel location at the various outside temperatures in Figs. 5, 6, 7, and 8. As can be seen, the curves for each panel location have a characteristic shape even though the difference in temperature between air near the floor and ceiling becomes smaller as the load decreases.

Several of the curves show dotted portions near the floor. In these cases, the curves are accurate down to the last temperature of air near the floor, but due to a faulty thermocouple used in the early tests, the floor surface temperatures measured were inaccurate. The dotted portions shown represent the probable continuation of the curves based on experience from later, accurate tests at other loads.

During the heating season over which these temperature measurements were made, several measurements of air velocity between floor and ceiling were taken. The instrument used for these measurements was the thermal anemometer which can be seen in Fig. 2, located to the right of the thermocouple stand. These investigations at several conditions generally showed slightly higher velocities near the

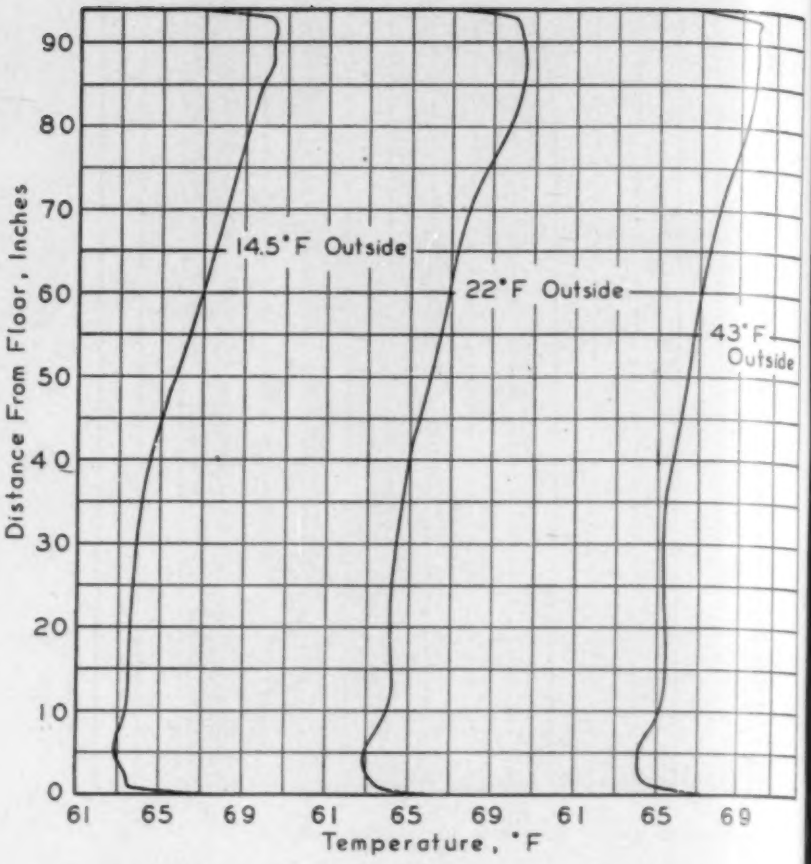

Fig. 8—Air temperature gradients—interior wall panel heating

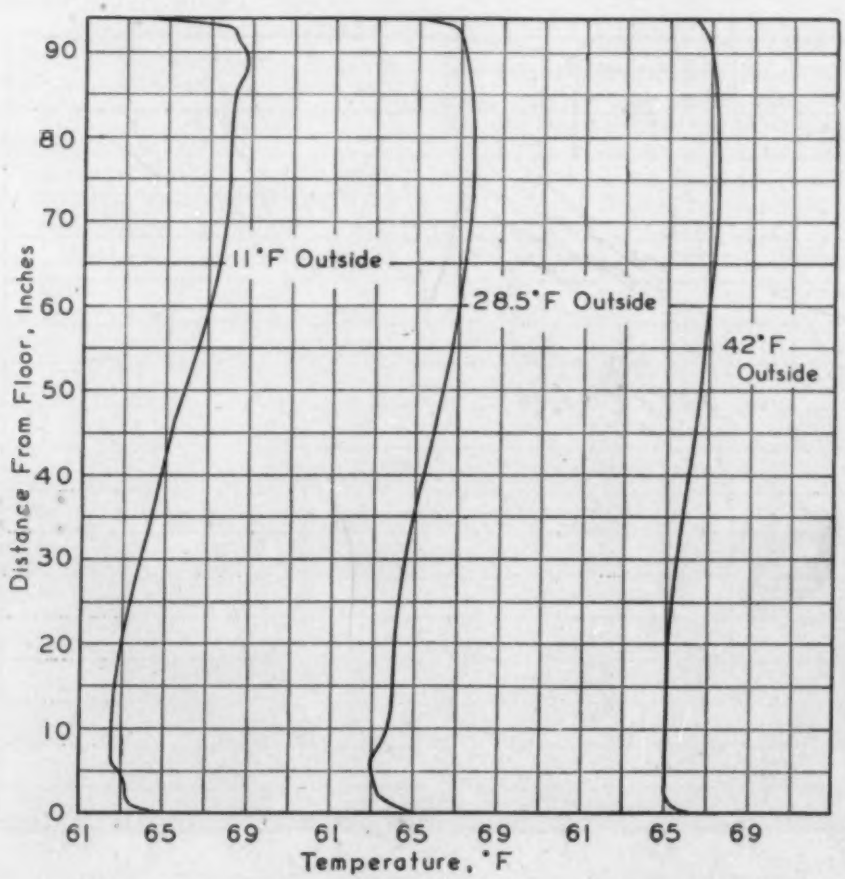

Fig. 7—Air temperature gradients—exterior wall panel heating

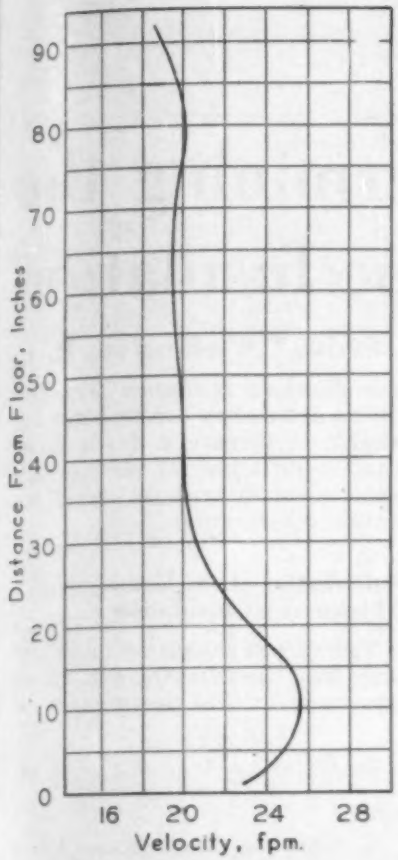

Fig. 9—Typical velocity distribution—ceiling panel heating

floor than near the ceiling. The velocities measured were always between 15 fpm and 30 fpm. A typical velocity gradient from floor to ceiling is shown in Fig. 9. Based on the brief investigations made, the velocity measurements did not indicate an adequate explanation for the temperature gradients except for the irregularities in the gradients near the floor. The velocity investigations, however, were by no means exhaustive, and the results should not be taken as final and general.

The curves indicate certain definite characteristics for this structure under the conditions which apply. For example, the unheated floor surface temperatures are always higher than the air temperature above the surface. On the other hand, the unheated ceiling surface temperatures are usually lower than the air temperatures immediately below. An explanation of these curve shapes near the floor and ceiling is possible if a heat balance is obtained for a section of the surface considered. For example, the ceiling gradients show a higher floor temperature than air temperature directly above the floor. There are three paths of heat flow involved at the floor: heat flows to the floor by direct radiation from the warm ceiling, heat flows from the surface by conduction through the floor slab to the cooler ground below, and heat flows from the floor by convection to the air above. If the heat lost by conduction were greater than that to the slowly moving air above the floor there would be a net heat flow downward, with the result that even though the surface was warmer than the air directly above it, heat would be lost through the floor. This prediction was borne out by experiment and calculation. With ceiling panel heating at a medium load, the radiant energy transfer to a small area below the center of the ceiling coil area was calculated to be 5.4 Btu per (hr) (sq ft). By an approximate calculation, assuming free convection conditions, the transfer to the air was found to be 0.9 Btu per (hr) (sq ft). Using a thermopile heat meter, the net heat flow from this area of the floor was found to be downward from the surface at a rate of 4.1 Btu per (hr) (sq ft). This gives a total dissipation of heat from the floor of 5.9 Btu per (hr) (sq ft) as compared to 5.4 Btu per (hr) (sq ft) received, or a balance within 10 per cent. Similar reasoning can be applied to rationally explain gradient shapes at the ceiling.

Conclusions

The results of this investigation indicate that floor panel operation caused uniform air temperatures within ½ F deg between one foot above and below the floor and ceiling respectively; this uniformity was maintained independent of load. The ceiling panel gradient, however, shows a maximum variation of 8 F deg between the same points and a minimum variation of 4.5 F deg, the variation increasing with load. Air temperature gradients for exterior wall and interior wall panel operation exhibited almost identical curves and were an approximate mean between the floor and ceiling gradient shapes. Since these investigations concern only one structure, further tests of the same type in buildings of different construction and under different loading conditions would prove of interest.

Acknowledgment

The authors wish to express their deep appreciation to Prof. F. W. Hutchinson for his encouragement, guidance, and helpful suggestions during these investigations.

JOURNAL SECTION

R. P. HANKINS, CONSULTANT

Richard P. Hankins, an associate member of the Society, opened a consulting engineering office on September 2, 1947. He will specialize in the design and reports on all types of mechanical equipment for buildings.

After graduating from the Virginia Polytechnic Institute with a B.S. in electrical engineering in 1933, Mr. Hankins received a good background in electrical and mechanical engineering, working for engineering and architectural firms. He served as a commissioned officer in the U. S. Army during the 2nd World War, and was a mechanical and electrical engineering designer with Wiley and Wilson, consulting engineers, prior to the opening of his own consulting office.

PERMANENT WORLD ENGINEERING CONFERENCE

Furtherance of plans for a permanent World Engineering Conference, in which American engineers are playing a leading role, was announced at a meeting of the council and executive board of the Conference in Zurich, Switzerland, September 9 to 12. Stewart E. Reimel, secretary of the committee on international relations of the Engineers Joint Council, with headquarters at 29 West 39 St., New York, N. Y., represented the United States National Committee for the World Engineering Conference.

Provisional plans for the international technical body were made at a meeting of engineers and scientists held in Paris last September. The U.S. committee is sponsored by three of the leading engineering societies in this country, the *American Society of Civil Engineers*, The *American Society of Mechanical Engineers* and the *American Institute of Chemical Engineers*.

Eight other nations signed the minutes at the Paris meeting, and others are expected to come in, making the project world wide in scope. The advancement of engineering knowledge and the exchange of technical information among countries for the benefit of all are aims of the Conference.

Mr. Reimel will remain in Europe to represent The *ASME* at the centenary of the Royal Netherlands Institution of Engineers at The Hague.

JOURNAL SECTION

Rapid Method of Determining the Economical Thickness of Pipe Insulation

By Utley W. Smith,* Washington, D. C.

SUMMARY — Rising fuel and labor costs make maximum heat savings with properly insulated steam lines desirable. A method for the rapid determination of the most economical thickness of pipe insulation is described. Included is a complete set of tables of economical thicknesses of pipe insulation for varying hours of operation, cost of heat, rate of amortization, temperature range, and pipe size. Although the data are based on 85 per cent magnesia, the procedure used can be applied to any type of insulation.

IT IS not often that a particular thickness of insulation is selected on the basis of economical thickness calculations. The common procedure is to use tables of recommended thickness of insulation based on pipe size and temperature range of operation only. Because such tables are based on cost factors which have changed rapidly in recent years and no longer prevail and because they do not allow for variation of hours of operation, rate of amortization, and cost of heat, the thicknesses recommended in these tables are not the most economical for operating conditions prevalent today.

In the past 20 years there has been a 40 to 45 per cent increase in the total production cost of steam, despite the fact that boiler efficiency has gone up approximately 15 per cent in the same period. This increase in steam production cost can be traced to the increased cost of fuel, labor, equipment and maintenance, and there is every indication that these costs will remain at, or rise above, present levels. It is therefore important that full advantage be taken of the heat savings made possible by use of the proper thickness of insulation.

The principles involved in determining the most economical size of machinery or thickness of insulation are identical. The desired result in either case is the maximum net saving of money for any given condition. The economical thickness of insulation is that thickness at which the sum of the annual cost of insulation and of the annual cost of the heat loss is at a minimum.

To aid the engineer in the selection of an insulation thickness of 85 per cent magnesia for a particular set of conditions without the necessity of extensive calculations, the *Magnesia Insulation Manufacturers Association* considered it advisable to prepare a set of tables that would allow for all the variables involved and yet would not be too cumbersome.

Calculation of the Economical Thickness of Insulation

Table 1 was calculated in accordance with the following well-known equations for heat transmission:

$$q_o = \frac{k\,(t_1 - t_2)}{r_2 \log_e \frac{r_2}{r_1}} \qquad \text{.....(1)}$$

where

q_o = Btu per (hour) (square foot of outer surface of insulation).

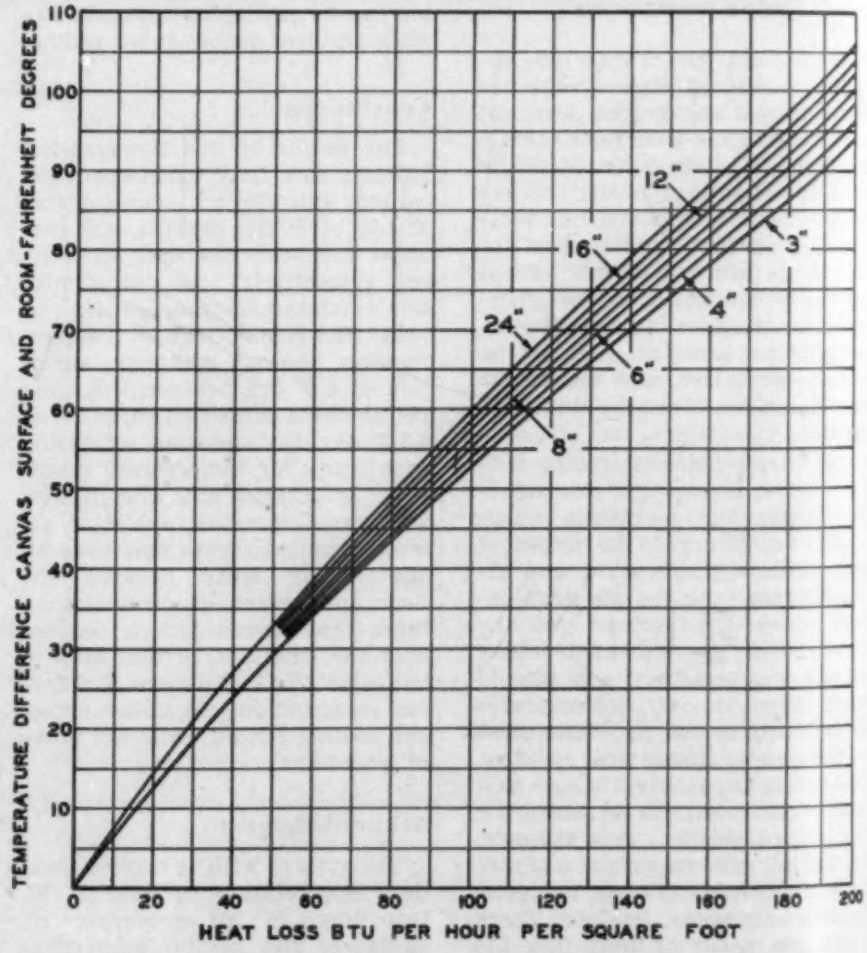

Fig. 1—Heat loss from canvas-covered cylindrical surfaces of various diameters

*Manager, the *Magnesia Insulation Manufacturers Association.*

Table 1—Unit heat loss for 85 per cent magnesia pipe insulation

Unit heat loss expressed in Btu per (lineal foot) (Fahr degree temperature difference) (hour). Approximately 75 F indoor air temperature

Nominal Pipe Size In.	Insulation Thickness[a] In.	Temperature Difference (Pipe-Air) Fahr Deg 100	200	300	400	500
½	Standard	0.158	0.166	0.173	0.180	0.187
	1½	0.126	0.131	0.136	0.141	0.146
	Dbl. Std.	0.114	0.118	0.123	0.128	0.133
	2	0.112	0.116	0.121	0.125	0.129
	3	0.095	0.099	0.103	0.107	0.110
¾	Standard	0.181	0.189	0.198	0.206	0.214
	1½	0.141	0.147	0.152	0.158	0.164
	Dbl. Std.	0.128	0.133	0.138	0.143	0.147
	2	0.124	0.129	0.134	0.139	0.144
	3	0.105	0.109	0.112	0.117	0.121
1	Standard	0.208	0.217	0.226	0.236	0.245
	1½	0.159	0.165	0.172	0.179	0.186
	Dbl. Std.	0.141	0.147	0.153	0.159	0.165
	2	0.139	0.145	0.151	0.156	0.161
	3	0.117	0.121	0.126	0.130	0.135
1¼	Standard	0.242	0.254	0.265	0.276	0.287
	1½	0.181	0.189	0.197	0.205	0.213
	Dbl. Std.	0.162	0.168	0.175	0.181	0.187
	2	0.157	0.164	0.170	0.177	0.183
	3	0.130	0.135	0.140	0.145	0.150
1½	Standard	0.263	0.276	0.289	0.301	0.314
	1½	0.197	0.206	0.214	0.222	0.230
	Dbl. Std.	0.175	0.182	0.189	0.196	0.203
	2	0.170	0.177	0.184	0.191	0.198
	3	0.139	0.145	0.150	0.156	0.161
2	Standard	0.282	0.295	0.308	0.321	0.334
	1½	0.227	0.237	0.247	0.257	0.266
	2	0.194	0.202	0.210	0.218	0.227
	Dbl. Std.	0.187	0.194	0.202	0.209	0.216
	3	0.157	0.163	0.169	0.175	0.191
2½	Standard	0.322	0.337	0.352	0.367	0.382
	1½	0.259	0.270	0.281	0.293	0.303
	2	0.219	0.228	0.237	0.246	0.255
	Dbl. Std.	0.210	0.218	0.226	0.235	0.244
	3	0.175	0.182	0.189	0.195	0.202
3	Standard	0.377	0.394	0.411	0.428	0.445
	1½	0.297	0.310	0.323	0.336	0.349
	2	0.249	0.259	0.270	0.280	0.290
	Dbl. Std.	0.239	0.248	0.258	0.268	0.288
	3	0.196	0.204	0.212	0.220	0.228
3½	Standard	0.416	0.437	0.457	0.477	0.497
	1½	0.326	0.341	0.356	0.370	0.384
	2	0.273	0.284	0.295	0.307	0.318
	Dbl. Std.	0.261	0.271	0.282	0.292	0.302
	3	0.214	0.222	0.231	0.240	0.249
4	Standard	0.431	0.451	0.471	0.491	0.511
	1½	0.358	0.373	0.388	0.404	0.420
	2	0.298	0.310	0.322	0.334	0.346
	Dbl. Std.	0.275	0.286	0.298	0.309	0.320
	3	0.231	0.240	0.249	0.258	0.268
5	Standard	0.515	0.540	0.565	0.589	0.613
	1½	0.421	0.440	0.458	0.477	0.496
	2	0.345	0.360	0.375	0.389	0.404
	Dbl. Std.	0.316	0.329	0.342	0.355	0.368
	3	0.266	0.277	0.288	0.299	0.310
6	Standard	0.596	0.623	0.650	0.677	0.704
	1½	0.485	0.507	0.528	0.550	0.571
	2	0.396	0.413	0.430	0.447	0.464
	Dbl. Std.	0.359	0.374	0.389	0.404	0.419
	3	0.302	0.314	0.326	0.338	0.350
8	Standard	0.686	0.718	0.750	0.782	0.814
	1½	0.602	0.629	0.656	0.683	0.710
	2	0.490	0.511	0.532	0.552	0.573
	Dbl. Std.	0.418	0.435	0.452	0 469	0.485
	3	0.368	0.382	0.397	0.411	0.426
10	Standard	0.829	0.869	0.908	0.947	0.986
	1½	0.726	0.759	0.792	0.824	0.857
	2	0.589	0.614	0.638	0.663	0.688
	Dbl. Std.	0.500	0.520	0.540	0.560	0.580
	3	0.434	0.452	0.470	0.488	0.506
12	Std. & 1½	0.843	0.881	0.920	0.958	0.997
	2	0.677	0.707	0.737	0.766	0.795
	3	0.500	0.520	0.540	0.560	0.580
14	Std. & 1½	0.920	0.962	1.003	1.044	1.085
	2	0.735	0.766	0.798	0.829	0.861
	3	0.540	0.562	0.583	0.605	0.627
16	Std. & 1½	1.039	1.085	1.131	1.177	1.222
	2	0.827	0.863	0.899	0.935	0.970
	3	0.604	0.629	0.653	0.677	0.701
18	Std. & 1½	1.152	1.207	1.259	1.310	1.361
	2	0.919	0.960	1.000	1.039	1.079
	3	0.665	0.693	0.721	0.748	0.775
20	Std. & 1½	1.264	1.324	1.382	1.440	1.498
	2	1.007	1.049	1.093	1.137	1.181
	3	0.728	0.758	0.788	0.818	0.848
24	Std. & 1½	1.493	1.563	1.634	1.705	1.775
	2	1.188	1.239	1.290	1.341	1.392
	3	0.856	0.890	0.925	0.960	0.995

[a]The following thicknesses were used for Standard and Double Standard:

Nominal Pipe Size In.	Standard In.	Double Standard In.
½ to 1½	⅞	1⅞
2 to 3½	1⅛	2⅛
4	1⅛	2¼
5 and 6	1⅛	2⅛
8 to 10	1¼	2½
12 and over	1½	3

Table 2—Applied costs[a] per lineal foot of 85 per cent magnesia pipe insulation

Nominal Pipe Size In.	Thickness of Insulation Standard[b]	1½ In.	2 In.	Double Standard[b]	3 In.
½	$0.274	0.430	0.6315	0.6585	1.016
¾	0.287	0.4495	0.664	0.691	1.1135
1	0.3065	0.469	0.6965	0.7235	1.146
1¼	0.326	0.495	0.729	0.756	1.1785
1½	0.3455	0.521	0.7615	0.7885	1.2435
2	0.378	0.560	0.807	0.834	1.3215
2½	0.404	0.599	0.8396	0.899	1.3865
3	0.449	0.651	0.9175	0.977	1.497
3½	0.482	0.6895	0.9825	1.042	1.594
4	0.560	0.742	1.0605	1.185	1.705
5	0.625	0.820	1.1905	1.315	1.900
6	0.703	0.898	1.301	1.491	2.076
8	0.937	1.0995	1.536	1.902	2.4145
10	1.094	1.3215	1.822	2.487	2.972
12	[c]	1.5955	2.148	[d]	3.505
14	[c]	1.784	2.369	[d]	3.830
16	[c]	1.9995	2.617	[d]	4.310
18	[c]	2.214	2.864	[d]	4.740
20	[c]	2.400	3.150	[d]	5.078
24	[c]	2.800	3.580	[d]	5.860

[a]Based on a 1947 cost survey made among insulation contractors in various sections of the country.
[b]Use 1½ In. Column.
[c]Use 3 In. Column.

r_1 = outer radius of pipe or inner radius of insulation, inches.
r_2 = outer radius of insulation, inches.
k = thermal conductivity of insulation, Btu per (hour) (square foot) (Fahrenheit degree per inch).
t_1 = temperature of inner surface of insulation, Fahrenheit degrees.
t_2 = temperature of outer surface of insulation, Fahrenheit degrees.

and

$$U_1 = q_o \left(\frac{2\pi r_2}{12}\right) \div (t_1 - t_a) \quad \ldots (2)$$

where

U_1 = unit heat loss per lineal foot of pipe = coefficient of heat transfer, Btu per (hour) (lineal foot of pipe) (Fahrenheit degree temperature difference between the inner surface of insulation and air)
t_a = temperature of air on cool side of insulation, Fahrenheit degrees

The relation between heat loss and temperature difference is shown in Fig. 1.

The values of k for 85 per cent magnesia for calculating heat losses were obtained from a conductivity curve based on the following data, which represent averages of the results of numerous conductivity tests carried out by the insulation manufacturers:

Mean Temperature of 85 Per Cent Magnesia—Fahr Deg	k
100	0.39
300	0.45
500	0.51

Table 3—Index to economical thickness of insulation tables

Per Year		Table Number								
Estimated Hours Operation	Per Cent Fixed Charges	Cost of Heat, Dollars Per Million Btu								
		$0.20	$0.25	$0.30	$0.35	$0.40	$0.45	$0.50	$0.55	$0.60
8760	15	8	9	10	11	12	12	13	13	13
7200	15	8	9	9	10	11	11	12	12	13
6000	15	7	8	9	9	10	10	11	11	12
5000	15	6	7	8	8	9	10	10	11	11
8760	20	7	8	9	10	10	11	11	12	12
7200	20	6	7	8	9	9	10	10	11	11
6000	20	5	6	7	8	9	9	10	10	10
5000	20	5	6	6	7	8	8	9	9	10
8760	25	6	7	8	9	9	10	10	11	11
7200	25	5	6	7	8	8	9	9	10	10
6000	25	4	5	6	7	8	8	9	9	9
5000	25	4	5	5	6	7	7	8	8	9

Table 4—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation				
	Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std	Std.	1½
212 to 266	Std.	Std.	Std.	Std.	1½
267 to 337	Std.	Std.	Std.	Std.	1½
338 to 387	Std.	Std.	Std.	Std.	1½
388 to 499	Std.	Std.	Std.	Std.	1½
500 to 600	Std.	Std.	Std.	Std.	1½

[a]Refer to Table 3.

Table 5—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation				
	Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	Std.	1½
212 to 266	Std.	Std.	Std.	Std.	1½
267 to 337	Std.	Std.	Std.	Std.	1½
338 to 387	Std.	Std.	Std.	Std.	1½
388 to 499	Std.	Std.	Std.	Std.	1½
500 to 600	Std.	Std.	1½	1½	1½

[a]Refer to Table 3.

Table 6—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation				
	Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	Std.	1½
212 to 266	Std.	Std.	Std.	Std.	1½
267 to 337	Std.	Std.	Std.	Std.	1½
338 to 387	Std.	Std.	Std.	Std.	1½
388 to 499	Std.	Std.	Std.	1½	1½
500 to 600	Std.	Std.	1½	1½	2

[a]Refer to Table 3.

Table 7—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation				
	Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	Std.	1½
212 to 266	Std.	Std.	Std.	Std.	1½
267 to 337	Std.	Std.	Std.	Std.	1½
338 to 387	Std.	Std.	Std.	1½	1½
388 to 499	Std.	Std.	1½	1½	1½
500 to 600	Std.	1½	1½	2	2

[a]Refer to Table 3.

Table 8—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation				
	Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	Std.	1½
212 to 266	Std.	Std.	Std.	Std.	1½
267 to 337	Std.	Std.	Std.	Std.	1½
338 to 387	Std.	Std.	1½	1½	1½
388 to 499	Std.	1½	1½	1½	2
500 to 600	1½	1½	1½	2	2

[a]Refer to Table 3.

Table 9—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation				
	Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	Std.	1½
212 to 266	Std.	Std.	Std.	Std.	1½
267 to 337	Std.	Std.	1½	1½	1½
338 to 387	Std.	1½	1½	1½	2
388 to 499	Std.	1½	1½	2	2
500 to 600	1½	1½	Dbl. Std.	2	2

[a]Refer to Table 3.

The costs listed in Table 2 were based on a 1947 cost survey made among heat insulation contractors in various sections of the country. These cost figures are *paste and band* costs on straight pipe and do not include the costs of such variables as fittings, valves, protective covering, scaffolding, etc.

The following example illustrates the various steps required for obtaining the values listed in Tables 4 to 13:

Determine the economical thickness of pipe insulation to be applied to a 3½ in. pipe at 200 psi steam (388 F) with average air temperature at 75 F. The annual fixed charges are 15 per cent, the annual hours of operation are 8,760, and the cost of steam is $0.40 per million Btu. The insulating material is 85 per cent magnesia

For standard thickness (1 1/2 in.) of 85 per cent magnesia:

Step A—Annual cost of insulation per linear foot of pipe = applied cost per linear foot standard thickness (Table 2) x fixed costs per year = $0.482 x 15 per cent = $0.072 per year

Step B—Annual cost of heat loss per linear foot of insulated pipe = unit heat loss (Table 1) x annual hours of operation x temperature difference between pipe and air x cost of heat per million Btu = 0.46 x 8,760 hours/year x 313 F x $0.40/$10^6$ = $0.505 per year

Step C—Total yearly cost = 0.072 + 0.505 = $0.577 per linear foot.

Similar calculations for the other available thicknesses give the following results:

Insulation Thickness Inches	Total Yearly Cost Per Linear Foot
1½	$0.496
2	0.473
2 1/2 (Double Standard)	0.466
3	0.493

The economical thickness in this example would be Double Standard since the sum of the annual cost of insulation and the annual cost of the heat loss is at a minimum for that thickness of insulation.

The foregoing procedure was repeated for varying hours of operation, cost of heat, etc., and the results were then tabulated.

Using the Economical Thickness Insulation Tables

With the use of the tables, the selection of the economical thickness for the previous example can be made in a moment's time. The index (Table 3) indicates the proper economical thickness table for given hours of operation, fixed charges, and heat cost. For the previous example the table indicated is Table 12. In Table 12 under the pipe size and operating temperatures given in the example, the thickness is determined to be Double Standard. Similarly the insulation thickness for any set of operating conditions can be determined quickly and accurately with the use of Table 3 and Tables 4-13. Following the procedure outlined in the foregoing, a similar series of tables can be drawn up for any other kind of insulation if the unit heat loss and applied cost data of the desired insulation are substituted for those of 85 per cent magnesia.

Conclusions

1. Increased costs make desirable a more precise determination of the thickness of insulation required for a particular installation.

2. The tables in current use for determining insulation thickness do not take into consideration all the variables involved.

3. A method has been presented whereby the economical thickness of insulation for varying operating conditions and based on current costs can be determined quickly and accurately.

Bibliography

1. Heat Transfer Through Insulation in the Moderate and High Temperature Fields—A Statement of the Existing Data, by L. B. McMillan. (*ASME Transactions*, Vol. 48, 1926, p. 1269).

2. Surface Transmission, by R. H. Heilman. (*ASME Transactions*, Fuels Steam Power, 51, 257, 1929).

Table 10—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation — Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	Std.	1½
212 to 266	Std.	Std.	Std.	1½	1½
267 to 337	Std.	Std.	1½	1½	1½
338 to 387	Std.	1½	1½	2	2
388 to 499	1½	1½	1½	2	2
500 to 600	1½	Dbl. Std.	Dbl. Std.	Dbl. Std.	2

[a]Refer to Table 3.

Table 11—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation — Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	Std.	1½
212 to 266	Std.	Std.	1½	1½	1½
267 to 337	Std.	1½	1½	1½	2
338 to 387	1½	1½	1½	2	2
388 to 499	1½	1½	Dbl. Std.	2	2
500 to 600	1½	Dbl. Std.	Dbl. Std.	Dbl. Std.	3

[a]Refer to Table 3.

Table 12—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation — Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	Std.	1½	1½
212 to 266	Std.	Std.	1½	1½	2
267 to 337	1½	1½	1½	2	2
338 to 387	1½	1½	Dbl. Std.	2	2
388 to 499	1½	Dbl. Std.	Dbl. Std.	Dbl. Std.	3
500 to 600	1½	Dbl. Std.	Dbl. Std.	3	3

[a]Refer to Table 3.

Table 13—Economical thickness of insulation[a]

Temperature Fahr Deg	Thickness of Insulation — Pipe Size				
	½ to 1½	2 to 3	3½ to 6	8 to 10	12 & over
180	Std.	Std.	1½	1½	1½
212 to 266	Std.	1½	1½	2	2
267 to 337	1½	1½	Dbl. Std.	2	2
338 to 387	1½	Dbl. Std.	Dbl. Std.	Dbl. Std.	3
388 to 499	1½	Dbl. Std.	Dbl. Std.	3	3
500 to 600	2	Dbl. Std.	3	3	3

[a]Refer to Table 3.

In Old New York 54th Annual Meeting of ASHVE

A scene in Central Park looking south

PLANS are well under way for the reception of members who will attend the Society's 54th Annual Meeting at the Hotel Commodore in New York, Feb. 2-5, 1948.

The Committee on Arrangements of the New York Chapter is planning an interesting program for both members and ladies. Reports of the committees in charge of the entertainment features made at the September 8 meeting indicate that there will be plenty to do every minute.

The Meetings Committee is planning technical sessions for Monday, Tuesday, Wednesday and Thursday, and there will be an interesting panel session to discuss the heat pump as a means of heating and cooling.

Members will receive an early announcement about the special events and should indicate their choice of events so that the Committee on Arrangements can plan accordingly.

Already hotel reservations are heavy and members are urged to use the special forms provided for them. Housing for ASHVE members has been arranged at the Hotel Commodore where technical meetings will be held and at the Barclay, the Biltmore, the Roosevelt and Belmont Plaza Hotels.

Numerous committees will arrive early for conferences in advance of the Society meeting. The Chapter Delegates will meet on the first day, Feb. 2, to select members of the Nominating Committee and to discuss other business of importance to the local chapters.

The Council and Committee on Research will hold meetings to transact the business of the Society and to adopt a program of investigations for the coming year.

In addition to the attraction of the Society's meeting the 8th International Heating and Ventilating Exposition at Grand Central Palace will focus attention on new developments in heating and air conditioning. With nearly all of the space taken on four floors of Grand Central Palace by exhibitors, indications are that it will be one of the largest exhibitions of its kind.

The President of New York Chapter and chairman of the Reception Committee, Prof. M. C. Giannini, speaking for the members of the Chapter says, "Come to New York, a cordial welcome awaits you."

The Committee on Arrangements consists of: *General Chairman*, Walter E. Heibel; *Honorary Chairmen*, Homer Addams, W. H. Driscoll, W. L. Fleisher, D. D. Kimball and Alfred J. Offner; *Vice Chairmen*, Peter B. Gordon, H. S. Johnson, Carl F. Kayan, C. S. Koehler and H. J. Ryan. Committee Chairmen: *Banquet*—W. A. Swain; *Entertainment*—H. J. Rose; *Exposition*—C. P. Roth; *Finance*—W. M. Heebner; *Ladies*—H. S. Wheller; *Publicity*—Clifford Strock; *Reception*—M. C. Giannini; *Sessions*—H. S. Birkett; *Secretary*, Carl H. Flink.

The skyline at the southern tip of Manhattan Island as seen from Governor's Island

1948 NOMINATIONS

Nominations for Officers and Council

The Nominating Committee selected in accordance with the provisions of **Art. B-VIII**, *Section 11* of the By-Laws, has submitted their selection of nominees for officers and members of Council in 1948, as follows:

For President:
G. L. TUVE, Cleveland, Ohio

For First Vice-President:
A. E. STACEY, JR., Syracuse, N. Y.

For Second Vice-President:
L. T. AVERY, Cleveland, Ohio

For Treasurer:
L. E. SEELEY, Durham, N. H.

For Members of the Council:

Three-Year Term

D. M. ALLEN, Kansas City, Mo.
F. A. HAMLET, Montreal, Que., Canada
C. S. LEOPOLD, Philadelphia, Pa.
H. E. SPROULL, Cincinnati, Ohio

Respectfully submitted,

NOMINATING COMMITTEE,

NEIL H. PETERSON, *Chairman*
JOHN E. HAINES, *Secretary*

H. E. ADAMS	JOHN JAMES	C. H. PESTERFIELD
A. W. EDWARDS	L. F. KENT	REX VERNON
J. ROLLINS GARDNER	A. S. MORGAN	E. C. WILLEY

Alternates

LEO GARNEAU — L. T. MART

In accordance with the provisions of the Society's Constitution, By-Laws, and Rules, ballots containing the names of the above candidates will be sent to the membership for voting upon prior to the Annual Meeting in February.

Art. B-IX—*Section 1.* Twenty (20) or more members of the Society, eligible to vote, may present to the Secretary, over their signatures, the name of any member eligible to hold office in the Society as a candidate for any office, provided such name is presented at least (60) days preceding the next Annual Meeting, together with the written consent of the nominee to fill the office for which he has been selected, and the Secretary shall add such names to the ballot if they are not already included in the list of names presented in the formal report of the Nominating Committee. Such names when presented shall be included on the printed ballot, with special notation that they are presented by members independent of the Nominating Committee report. Any member nominated for any office may withdraw his name as a candidate, whether nominated by the regular Nominating Committee or by twenty (20) or more members, providing he does so at least forty-five (45) days prior to the next Annual Meeting.

Art. B-IX—*Section 2.* The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the provisions of **Art. B-VIII**—*Section 9*, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1948.

COMMITTEE ON RESEARCH:

Three-Year Term

A. B. ALGREN, Minneapolis, Minn.
M. C. GIANNINI, New York, N. Y.
F. W. HUTCHINSON, Berkeley, Calif.
C. W. JOHNSON, Windsor, Ont., Canada
W. E. ZIEBER, York, Pa.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

Art. B-VIII—*Section 9.* Committee on Research. There shall be a Committee on Research of fifteen (15) members, which shall function in accordance with the Regulations which govern the Committee on Research. The Council shall nominate previous to July first of each year, five (5) members of the Society, to serve for three (3) years, to replace the five (5) members of the Committee on Research whose terms expire at the close of the Annual Meeting of the Society following such nomination. The Council shall vote on the nominees by letter ballot, and the Secretary shall publish the names of the candidates nominated in the October issue of the JOURNAL.

ARTICLE II—RESEARCH REGULATIONS

(c) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(d) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(e) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

NOMINEES for 1948 OFFICERS

For President—G. L. Tuve, Cleveland, Ohio, head of the mechanical engineering department at Case Institute of Technology and 1st vice president of the ASHVE, was born on May 26, 1896, at Canton, S. D., where he attended public schools and Augustana Academy. He received his college training at Augustana College, Sioux Falls, S. D.,

G. L. Tuve
Cleveland, Ohio

Northwestern University and the University of Minnesota where he specialized in mechanical and industrial engineering, with supplementary work in economics and business administration.

Upon graduating from Northwestern University in 1920, with a B. S. degree he became associated with the Mahr Mfg. Co., Minneapolis, Minn., as an experimental engineer. In 1921, he received his M. E. from the University of Minnesota and joined the faculty as an instructor and assistant professor of mechanical engineering. During this time he also acted as assistant professor of mechanical engineering at the University of Montana. In 1926 he accepted a position as associate professor and head of the department of mechanical engineering at the Texas Technological College. He joined the faculty of the Case Institute of Technology in 1930 (then the Case School of Applied Science).

Professor Tuve has specialized in heating, ventilating, air conditioning, heat transmission and air flow, and received his industrial experience as a consultant on research and development work with such firms as the Chalmers Manufacturing Co., the American Locomotive Co., and the Public Service Co., of Northern Illinois. A contributor to many technical publications, Professor Tuve is the co-author with Professor C. F. Shoop, of a text book entitled *Mechanical Engineering Practice* which is widely used in engineering colleges.

Elected a member of the ASHVE in 1932, Professor Tuve has served the Society in many capacities, including the first and second vice presidency. In 1939 he was elected to serve a three-year term on the Council and in 1944 and 1945 he served as chairman of the Committee on Research. Prior to that he served a three-year term as a member of the Committee on Research and as chairman of its Research Executive Committee. He has served on many of the Society's Special Committees including Guide Publication, the Technical Papers and as chairman of the F. Paul Anderson Committee, and such Council Committees as Executive, Standards and as chairman of the current Meetings Committee. He served as president of the Northern Ohio Chapter in 1934 and 1936 and as a member of numerous Technical Advisory Committees.

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For First Vice President—Alfred E. Stacey, Jr., Syracuse, N. Y., was born on March 10, 1885 at Elbridge, N. Y. He received his preparatory education at the Munroe Collegiate Institute and obtained his M. E. degree from Syracuse University in 1906.

Following his graduation from the University he was employed as an engineer by the Buffalo Forge Co., Buffalo, N. Y., and in 1908 he joined the staff of the Carrier Air Conditioning Co., New York, as chief engineer. In 1909 he was appointed secretary and shop manager of the Elbridge Chair Co., Elbridge, N. Y., becoming its vice-president in 1911. Later that year he returned to Carrier Air Conditioning Co. as Western Manager with offices in Chicago. He remained in Chicago until May, 1919 when he became chief of research at Carrier Engineering Corp., Newark, N. J. In 1928 he became vice president in charge of research and in 1931 he was appointed vice president in charge of engineering. He served as vice president and technical sales advisor for the corporation in 1934 and 1935.

In December 1935 with A. C. Buensod he organized the firm of Buensod-Stacey Air Conditioning, Inc., New York and served as vice president until he entered the Navy for active service in 1941.

As Captain on the aircraft carrier *Lexington* he received the commendation of the Commander-in-Chief of the Pacific Fleet. During his Naval service Mr. Stacey made contributions to the improvement and design of naval vessels, of such importance that the military effectiveness of certain classes of vessels, including submarines in particular, was materially increased.

Mr. Stacey joined the ASHVE in 1914 when he was located in Chicago and became affiliated with the Illinois Chapter serving as Secretary from 1916 to 1919. Since that

A. E. Stacey, Jr.
Syracuse, N. Y.

time he has taken an active part in the activities of the New York Chapter. He has served on the Society's Council and on many of its special committees as well as a member of the Committee on Research, 1929-31, 1937-39 and as Chairman in 1940-1941. He has also served as chairman and as a member of many code committees and Technical Advisory Committees. He is chairman of the current Finance Committee and a member of the Executive Committee as well as the special committee on Business and Financial Policies.

At the 52nd Annual Meeting of the Society in January, 1946, Mr. Stacey was awarded the F. Paul Anderson Gold Medal for his outstanding contributions to the advancement of heating, ventilating and air conditioning.

He is the author of numerous papers and reports in scientific journals in the chemical, ceramic, and textile engineering fields.

Mr. Stacey is a member of the *American Society of Naval Engineers, American Institute of New York, American Society for Testing Materials, American Society for the Advancement of Science,* and the *Acoustical Society of America,* as well as the Delta Upsilon Fraternity.

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For Second Vice President—Lester C. Avery, Cleveland, Ohio, president of the Avery Engineering Co., was born in Painesville, Ohio, on August 28, 1896. He attended Shaw High School, Cleveland, and was graduated in 1918 from the Case School of Applied Science, now known as Case Institute of Technology, with a B.S. degree.

Mr. Avery started in the refrigeration business as an engineer for the Hibbard Co., Cleveland, in 1920, and in 1921 was appointed district

L. T. Avery
Cleveland, Ohio

manager in Cleveland for the American Carbonic Machinery Co. In 1928 he was moved to Chicago as district manager for the same company and returned to Cleveland in 1929 to start the Avery Engineering Co., which company he has managed since that time.

Some of the important projects which have been handled by the firm under Mr. Avery's direction are the Ben Venue Laboratories, Bedford; Ohio Bell Telephone Co., Cleveland, Columbus, Dayton, and Toledo; the Warner and Swasey Co., Cleveland; Columbus and Southern Ohio Electric Co.; Columbus Metropolitan Bank and City Loan and Savings Co., Lima; The Container Co., division of Continental Can Corp., Van Wert; Firestone Tire and Rubber Co., Akron; and the Hoover Co., North Canton.

A member of the ASHVE since 1934, Mr. Avery has been active in the affairs of both the National Society and the Northern Ohio Chapter. He served a three-year term on the Council from 1944-1946, serving as chairman of the Meetings Committee in 1946. Mr. Avery has also served on the Guide Publication Committee, on the Committee on Central Air Conditioning Research, and as chairman of the Constitution and By-Laws Committee in 1943. He was a member of the Research Finance Committee in 1939 and served as a member of the Technical Advisory Committees on Air Conditioning in Industry, and on Air Conditioning Requirements of Glass. In 1940 he served as general chairman of the Committee on Arrangements for the 53rd Annual Meeting in Cleveland.

He was elected president of the Northern Ohio Chapter during the 1936-1937 season, and served as a member of its board of governors from 1937-38. As an active member of the Chapter he served on many of its local committees including: Convention, Meetings, Nominating, Program, and Standards Committees.

Mr. Avery has written various technical articles which have been published in *Heating, Piping & Air Conditioning, Refrigerating Engineering, Heating and Ventilating,* and other trade publications.

In addition to being a member of the Society, Mr. Avery is also a member of the *American Society of Refrigerating Engineers,* the *Cleveland Engineering Society* (Board of Trustees, 1945-47), the Cleveland Rotary Club, the Cleveland Chamber of Commerce, the Case Alumni Council, and the Hermit Club. He is a member of Beta Theta Pi, national fraternity.

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For Treasurer—Lauren E. Seeley, Durham, N. H., Dean of the College of Technology, University of New Hampshire, was born on November 8, 1898 at Meridan, Conn. He attended Yale University from which he received his Ph.B. degree in 1921, his M.E. in 1924 and his LL.B in 1935.

While preparing for his degrees he taught mechanical engineering at Yale and in 1925 he was put in charge of a course in heating and ventilating, remaining at the University until 1945 when he was appointed to his present position at the University of New Hampshire.

JOURNAL SECTION

During the war years Dean Seeley served as consultant on engineering and manpower problems for a number of government agencies, trade associations and private firms. He also served as regional advisor in Connecticut and Rhode Island for the engineering, science and management war training program of the U.S. Office of Education and was

L. E. Seeley
Durham, N. H.

a special consultant to the OPA on fuel oil and coal rationing problems.

His research work has been concerned chiefly with heating and ventilating, including studies of wood burning devices and the effect of relative humidity on the respiratory system.

Dean Seeley is the author of numerous technical codes and papers which have been published in the Society's Journal and Transactions.

A member of the Society since 1930 he has had an active interest in its activities and in the affairs of the Connecticut Chapter since it was organized in 1940. He served a three-year term on the Council from 1944 and during this time served on several Council Committees, such as the Executive, Finance and Standards. He also served a three-year term as a member of the Publication Committee, serving as its chairman in 1946. Greatly interested in research he served as a member of a number of the Research Technical Advisory Committees. He was elected president of the Connecticut Chapter during the 1940-41 season and following his term of office he served as a member of its board of governors.

Dean Seeley is also a member of the *American Society of Mechanical Engineers* and of the Sigma Xi fraternity.

LIFE MEMBER DIES AT 71

Clarence H. Mosher, Buffalo, N. Y. manufacturers' representative, and recently elected Life Member of the Society, died on August 9, 1947, after a brief illness.

A native of Seneca Falls, N. Y., Mr. Mosher was born in 1876. After receiving an academic education, Mr. Mosher became a traveling representative for various firms in the heating specialty field. For several years he served as district representative for the Schaeffer and Budenberg Mfg., Co., and American Steam Gauge and Valve Mfg., Co. division, in Boston, Mass., and Brooklyn, N. Y. Prior to establishing his own business as a manufacturers' representative in 1931, Mr. Mosher was associated with the Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn., as a district sales representative. At the time of his death Mr. Mosher was direct factory representative for the J. E. Lonergan Co., Phila., Pa., and the Moeller Instrument Co., Richmond Hill, N. Y.

Mr. Mosher had been an Associate Member of the Society since 1919, and was active in the interests of the Society. He was also a member of the Western New York Chapter.

The Officers and Council of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS extend their deepest sympathy to his widow, Helene M. Mosher, and to his many close associates in the engineering profession.

M. I. BLUMENTHAL'S DEATH ANNOUNCED

Word has been received of the death a short time ago of M. I. Blumenthal, a member of the ASHVE since 1936. He had been retired from the office of the Maritime Commission, Oakland, Calif., since 1945.

Mr. Blumenthal was born in Cologne, Germany, on April 4, 1870. He received his elementary education at the Classical high school, Germany. His technical training was received at Senkenberg Tech, Frankfurt and the Polytechnicum at Zurich. While attending his technical courses, he served as a machinist's apprentice. In 1888 he became an assistant electrical engineer for the Wetzel, St. Gotthard Railway, Switzerland. During 1890-94 he served various firms in Germany and France as a surveyor for water and gas mains. For the next eight years he worked as an installation engineer for the Nobel dynamite factory. Later he started his own firm and was responsible for the installation of an air conditioning system for many buildings particularly in South America. In 1934 he joined the staff of the National Schools, Los Angeles, Calif, as an instructor and writer of correspondence lessons in refrigeration and air conditioning. He joined the Maritime Commission, west coast regional office, in 1942 as a mechanical and refrigeration engineer, and retired from active service in 1945.

Mr. Blumenthal was also an active member of the *ASRE*. The Officers and Council of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS join his many friends in the profession in extending their sympathy to his family.

H. A. BRINKER, DIES

H. A. Brinker, a member of the Society since 1934, died on April 27, 1947. He had been a member of the firm of Wilson-Brinker Co., sales engineers and manufacturers agents, Kalamazoo, Mich.

Born in Centerville, Mich., on March 8, 1899, Mr. Brinker received his preparatory education at Centerville High School. In 1923 he graduated from the University of Michigan with a B.S. in mechanical engineering. His first position was as an assistant engineer with the Underwriters' Laboratories, Oil Burner Div., Chicago, Ill. In 1925 he became service manager and installation engineer for the Wayne Tank and Pump Co., Fort Wayne, Ind. Three years later, he entered the employ of the Clarage Fan Co., as a sales engineer, and in 1934 he formed a partnership with R. W. Wilson.

Mr. Brinker had been an active member of the local Western Michigan Chapter. The Officers and Council of The AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, join his fellow chapter members in extending their heartfelt sympathy to his family for their sad loss.

DR. WICKENDEN, FORMER PRESIDENT CASE INSTITUTE, DIES

Dr. William E. Wickenden, noted engineer, died on September 2, 1947, a few hours after his retirement as president of Case Institute of Technology became effective. His death in Monadnock Community Hospital, Peterboro, N. H., occurred after he was stricken with a heart ailment while on vacation.

In his administration at Case he won national note in the field of engineering education and was an accomplished after dinner speaker.

Born in Toledo, Ohio, in 1882, he was graduated from Denison University in 1904, and took postgraduate work at the University of Wisconsin, where he was on the faculty. He was associate professor of electrical engineering at M.I.T. from 1914 to 1918. Later he was with the Western Electric Co. and American Telephone and Telegraph Co.

Honorary degrees had been conferred on him by Lafayette College, Worcester Polytechnic, Case School, Rose Polytechnic, Tulane, Denison, Bucknell, Oberlin and the University of Toledo.

Dr. Wickenden was active in many technical organizations. He was elected president of the *Society for the Promotion of Engineering Education* in 1933, and in 1935 was awarded its Lamme Medal. During 1945-46 he served as president of the *American Institute of Electrical Engineers*.

The Engineers Joint Council had recently named Dr. Wickenden as its representative to the United States Commission for UNESCO (United Nations Educational, Scientific and Cultural Organization.) He had applied his extensive technical knowledge in the service of many other government groups, including the Office of Production Management in 1941, when he served as chairman of the general products groups.

He is survived by his wife, Mrs. Marion Wickenden, a son William C. Wickenden, and a daughter, Mrs. Arthur Goldschmidt to whom the Officers and Council of the Society extend heartfelt sympathy.

Summary of Local Chapter Meetings*

MEMPHIS—August 18, 1947. Subject: Heating Problems in Connection with the Manufacture of Explosives. Speaker: R. E. Overman, Jr., engineer, J. E. Dilworth Co., Memphis, Tenn. R. H. Hoshall, acting president, thanked Mr. Overman on behalf of the chapter for his splendid talk. Attendance 12.

MEMPHIS—July 21, 1947. Subject: Refrigeration. Speaker: L. L. Arbuckle, chief engineer, Bell & Gossett Co., refrigeration div. Mr. Arbuckle gave an interesting talk on refrigeration as applied to his company's products. Attendance 29.

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NORTH TEXAS—August 18, 1947. Subject: Panel Discussion on Temperature Control, its Uses and Application. Speakers: R. G. Lyford, district manager, Powers Regulator Co., Dallas, M. A. Benson, district manager Johnson Service Co., Dallas, and J. P. Ashcraft, owner, J. P. Ashcraft Co., Dallas. Mr. Lyford, the chief speaker, reviewed temperature controls as used on various processes and processing plants. Commenting briefly on the use and application of the pneumatic type control system, Mr. Benson likened the pneumatic type thermostat to a simple pressure reducing valve. Mr. Ashcraft concluded the panel discussion with a brief but informative talk on combustion controls and their function. Members enjoyed the excellent talks given by the speakers, and many questions were asked during the discussion period. Other Features: Proposed revision of the Chapter's by-laws as recommended by the legislative committee was discussed and voted upon. Attendance 60. Attendance ratio 0.63.

NORTH TEXAS—July 21, 1947. Subject: Information Please Panel. Master of Ceremonies: J. P. Ashcraft, owner, J. P. Ashcraft Co., Dallas. Members of the panel were H. J. Martyn, plumbing and heating contractor; M. L. Brown, Dallas Air Conditioning Co., and H. J. Waggle, Sturtevant Div. Westinghouse Electric Corp. Members and guests enjoyed the question and answer period which included such topics as coil selection, temperature and zone selection, plumbing codes and back siphonage, and increased cost of construction. Other Features: President Gardner gave a report on the semi-annual meeting held at Coronado, Calif., and reported that Dr. B. M. Woods, national president, was invited to a fall meeting of the North Texas chapter. A report on proposed revision of the chapter by-laws was given by the legislative committee, and R. E. Allison, *chairman*, gave the report of the finance committee. Attendance 50. Attendance ration 0.62.

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OREGON—September 4, 1947. Subject: Proposed New Mechanical Warm Air Heating Code for Portland. Speakers: William Bowes, city commissioner, and Walter Bernard, director, Bureau of Buildings, Portland. Commissioner Bowes stated in his talk that the old code is obsolete because of new developments, and that the city needs the aid of industry in formulating a new code. Mr. Bernard stated that the Bureau of Buildings is a service organization to keep the public informed on building developments and it enlists the aid of many industrial organizations in its work. Following the interesting comments of the speakers, the meeting was opened to discussion. E. R. Lokey, vice president of the chapter, thanked Commissioner Bowes and Mr. Bernard for their informative talks. Other Features: A resolution was adopted expressing thanks and appreciation to those who helped make the annual stag picnic a success. Reports of the membership, meetings, and legislative committees were heard. Ray Chewning gave his report as treasurer. The editor of the Chapter's publication, *The Diffuser*, reported that the publication was making out well and that 250 copies of each issue have been published. Walter Simpson, chairman of the Air Conditioning Conference committee, stated that his report had been covered in *The Diffuser* and that members would be asked what subjects they would be interested in hearing discussed at the next conference. Attendance 98.

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ST. LOUIS—May 6, 1947. Subject: Review of book, *Our Fair City*, written by Allen. Speaker: Carlos F. Hurd, St. Louis Post Dispatch. Mr. Hurd in his interesting review of *Our Fair City*, which deals with the contempt for law and corruption in U.S. cities, read several excerpts about various cities. He dwelt mostly on the chapter concerning St. Louis, which he himself had prepared. Other features: Reports of several committees were heard, and a letter was read concerning the proposed Boiler and Pressure Vessel Law for the State of Missouri. New officers for the coming year were installed as follows: J. H. Carter, *president;* B. L. Evans, *1st vice president;* W. A. Russell, *2nd vice president;* J. S. Rosebrough, *secretary;* C. H. Burnap, *treasurer;* and L. L. Hamig, W. D. Thompson, Ralf Toensfeldt, and B. C. Simons, members of *board of governors*. Attendance 42.

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SOUTH TEXAS—July 22, 1947. Subject: Social Meeting. A stag party was held at the Houston Engineers' Club. Members and their guests enjoyed the games and refreshments. All regular business was dispensed with. Attendance 30. Attendance ratio 0.30.

*Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

JOURNAL SECTION

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When the replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 44 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by October 20, 1947, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

BEINEKE, ROBERT C., Engr., Fosdick & Hilmer. PROPOSERS: R. W. Sigmund, H. K. Jennings. SECONDERS: E. J. Richards, D. J. Wood.

BIRDSALL, HARRY W., Partner, The Arrow Co. PROPOSERS: W. R. Norte, P. F. Sandsted. SECONDERS: K. R. Murhard, J. B. Banks.

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Fuels: E. T. Selig, Jr., *Chairman;* P. R. Achenbach, J. F. Barkley, R. M. Conner*, W. A. Danielson, R. B. Engdahl, L. N. Hunter*, R. C. Johnson, S. Konzo, J. W. Miller, W. M. Myler, Jr., Harold J. Rose, T. H. Smoot, R. K. Thulman*, E. C. Webb.

Glass: R. A. Miller, *Chairman;* A. B. Algren, J. E. Frazier, J. S. Herbert, E. H. Hobbie, L. K. Jones, C. O. Mackey*, F. Preston, W. C. Randall, Vic Sanders, H. B. Vincent, G. B. Watkins.

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Industrial Ventilation: W. N. Witheridge, *Chairman;* A. D. Brandt, W. B. Harris, W. C. L. Hemeon, D. E. Humphrey, J. M. Kane, M. G. Kershaw, L. L. Lewis, L. G. Miller*, H. A. Mosher, Ralph Poole, B. F. Postman, B. R. Small, R. P. Warren, H. E. Ziel.

Insulation: E. R. Queer, *Chairman;* R. E. Backstrom, C. B. Bradley, H. E. Lewis, L. E. Pasek, H. E. Robinson, Vic Sanders, T. D. Stafford, R. K. Thulman*, T. T. Tucker, P. M. Woodworth.

Physiological Research: C.-E. A. Winslow, *Chairman;* Thomas Bedford, M.D., A. R. Behnke, M.D., A. C. Burton, M.D., E. F. DuBois, M.D., A. P. Gagge, F. W. Hutchinson*, R. W. Keeton, M.D., D. H. K. Lee, M.D., André Missenard, Charles Sheard.

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*Member of Committee on Research.

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Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. Meets, Third Monday. President, R. B. Breneman, 1282 Edgehill Rd., Columbus 8. Secretary, A. E. Norman, Jr., 1150 Chesapeake Ave., Columbus.

Cincinnati: Organized 1932. Headquarters, Cincinnati, Ohio. Meets, First Tuesday, President, H. K. Jennings, 1639 Union Trust Bldg., Cincinnati 2, Secretary, K. B. Little, 852 Temple Bar Bldg., Cincinnati 2.

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Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, W. A. Kuechenberg, 1714 Sheffield Ave., Chicago 14. Secretary, G. W. Bornquist, 629 W. Washington Blvd., Chicago 6.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, I. W. Cotton, 1035 N. Pennsylvania St., Indianapolis 4. Secretary W. R. Fenstermaker, 215 E. New York St., Indianapolis 4.

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Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, P. C. Leffel, 3323 Main St., Kansas City 2. Secretary, Henry Nottberg, Jr., 914 Campbell, Kansas City.

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Manitoba: Organized, 1935. Headquarters, Winnipeg, Man., Canada. Meets Third Thursday. President, D. S. Swain, 1186 Downing St., Winnipeg. Secretary, A. W. Moss, 26 Ferndale Ave., Norwood, Manitoba.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, P. A. Croney, 72 Arlington St., Newton. Secretary, R. T. Kern, 51 Claflin St., Leominster.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, N. C. Ledbetter, 22 S. Cooper St., Memphis 4. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, A. E. Knibb, 1003 Maryland Ave., Detroit 30. Secretary, L. A. Burch, 5853 Hamilton Ave., Detroit 2.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, L. C. Gross, 5324 Oaklawn Ave., Minneapolis 10. Secretary, L. J. Krause, 2753 4th Avenue S., Minneapolis 8.

Montreal: Organized, 1936. Headquarters, Montreal, Que., Canada. Meets, Third Monday. President, T. H. Worthington, 405 Beaubien St. W., Montreal, Que. Secretary, S. W. Salter, 910 New Birks Bldg., Montreal.

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Nebraska: Organized, 1940. Headquarters, Omaha, Neb. Meets, Second Tuesday. President, Verne Simmonds, 2416 Vane St., Omaha. Secretary, G. W. Colburn, 106 N. 15th St., Omaha 2.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, M. C. Giannini, New York University, New York 53. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, C. Z. Adams, 312 Piedmont Bldg., P. O. Box 1356, Greensboro. Secretary, M. F. DuChateau, 205 S. Lyndon St., Greensboro.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, C. R. Gardner, 1000 St. Louis St., Dallas 1. Secretary, G. A. Linskie, 3124 Milton St., Dallas 5.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, John James, 3170 W. 106th St., Cleveland 11. Secretary, W. M. Rowe, 1302 Swetland Bldg. Cleveland 15.

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Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, W. W. Frankfurt, 519 Apco Tower, Oklahoma City. Secretary, J. H. Spaan, Jr., 1303 N. Klein, Oklahoma City 6.

Ontario: Organized, 1922. Headquarters, Toronto, Ont., Canada. Meets, First Monday. President D. A. Stott, 195 Spadina Ave., Toronto. Secretary, H. R. Roth, 57 Bloor St., W., Toronto, Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, C. W. Brissenden, Electric Bldg., Portland 5. Secretary, L. G. Williams, Box 304, Gladstone.

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Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, E. H. Langdon, 72 Vine St., Seattle. Secretary, E. J. Rosen, 10238 18th Ave., S. W., Seattle 66.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, E. H. Dafter, 12 S. 12th St., Philadelphia 7. Secretary, E. K. Wagner, 2240 N. Broad St., Philadelphia, 32.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, D. W. Loucks, 435 Sixth Ave., Pittsburgh 19. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

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Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, J. F. Mohan, 2229 Blake St., Denver 2. Secretary, H. C. Kugeler, 2365 Ash St., Denver 7.

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St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, J. H. Carter, 710 Key West Ave., Webster Groves 19. Secretary, J. S. Rosebrough, 1014 Arcade Bldg., St. Louis 1.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, D. M. Mills, Gray and Crawford, Houston 1. Secretary, L. L. Ladewig, Box 1188, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, R. A. Lowe, 6381 Hollywood Blvd., Los Angeles 28. Secretary, John L. Blake, 1700 S. Bedford St., Los Angeles 35.

Southwest Texas: Organized, 1946. Headquarters, San Antonio, Tex. President, F. C. Benham, Jr., 702 S. Flores St., San Antonio. Secretary, L. S. Pawkett, 810 Insurance Bldg., San Antonio 5.

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Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, E. V. Gritton, 2470 S. 15th, Salt Lake City 5. Secretary, C. E. Ferguson, 838 Garfield Ave., Salt Lake City.

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Virginia: Organized, 1946. Headquarters, Norfolk, Va. President, R. C. Thomas, 819 Westover Ave., Norfolk 7. Secretary, J. F. Reynolds, Gatling and Marble Ave., Norfolk 2.

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Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, H. H. Hill, 438 Woodward Bldg., Washington 5. Secretary, J. G. Muirheid, 2013 New Hampshire Ave., N. W., Washington 9.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, Frank Harbin, Jr., 280 E. 6th St., Holland. Secretary, W. C. DeRoo, 500 E. 8th St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, G. E. Adema, 39 W. Balcom St., Buffalo 9. Secretary, J. H. Bryce, 88 E. Girard Blvd., Kenmore.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, Rex Vernon, 507 E. Michigan St., Milwaukee 2. Secretary, B. M. Kluge, 1817 S. 66th St., Milwaukee 14.

Student Branch

Texas A. & M. College: Organized, 1946. Headquarters, College Station, Tex. Meets, Third Thursday. President, G. H. Jackson, 225 W. Nevada St., El Paso. Secretary T. V. Burns, 2307 Driscoll, Houston 6.

EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1947 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Unit Conditioners Provide Heating, Cooling

No. 3558—Year 'round conditioning units in capacities of 2, 3, 5, and 7½ tons and incorporating the new "Ripple Fin" coil construction are offered by McQuay, Inc., 1600 Broadway N.E., Minneapolis 13, Minn.

Consisting of a steel cabinet, cooling and heating coils, centrifugal forward curved blower, a replaceable type filter, and motor, the units may be suspended from the ceiling or mounted on regular store fixtures. They are designed for use in offices, stores, shops, restaurants, etc., and are designed so that cooling may be effected with water or by direct expansion. Heating is accomplished by using hot water or steam coils. All cooling and heating coils are formed by hydraulic expansion of nonferrous tubes to specifically designed aluminum fins.

Pump Controls Pressure in Hydraulic Systems

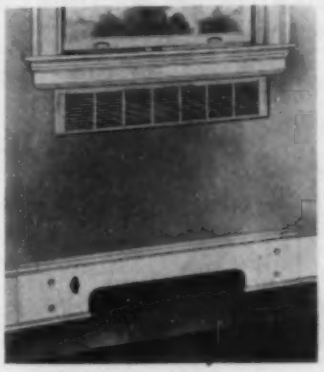
No. 3559**—A compact "unloading" pump designed to eliminate many pieces of equipment ordinarily required has been announced by the Pesco Products Div., Borg-Warner Corp., 310 S. Michigan Ave., Chicago, Ill.

The new pump is of the hydraulic gear type and is essentially two pumps within a single housing. A pilot valve controls an opening in the passage communicating from the outlet port to the rear of the movable bearings in the cover of the pump. When a specified pressure has been reached in the hydraulic system, the pilot valve closes the passage to the rear of the bearings, thus eliminating the "pressure loading". The pressure on the gear teeth area forces the cover bearings away from the gears, and immediately the large section of the pump ceases to deliver fluid with a consequent decrease in horsepower input requirement.

The small section of the pump continues to deliver fluid under pressure which keeps the hydraulic system alive. Excess fluid delivered by the small section of the pump, beyond that required to offset system leakage, is returned to the system reservoir through the relief valve.

When the hydraulic actuator is required and the selector valve in the system is operated, the system pressure immediately begins to drop off or decrease. When the system pressure falls to the lower limit at which the pilot valve is set, pressure loading is reestablished in the large section of the pump. The pump then continues to deliver full capacity as long as the requirement exists, at which time it again unloads.

Prefabricated Radiators Concealed in Plaster Walls



No. 3560—Warren Webster & Co., Camden, N. J., have announced construction details of a new line of prefabricated concealed convectors for controlled steam heating. Recessed under windows and concealed in plaster walls, the radiation is said to be especially suitable for many types of new construction, including religious buildings, banks, schools, hospitals, hotels, libraries, apartments, railroad stations, office buildings, and fine residences.

The system combines in a single unit the heating element, supply valve, return trap, and union connections. The heating element is contained in a sheet metal enclosure with openings at top and bottom for natural convected air movement. Provision has been made in all types of enclosures for control of heat by extending the supply valve handle through the enclosure. The valve permits complete shut-off so that damper control is not used.

A wide choice of radiator sizes in each of five types of enclosures permits selection of standard units to meet almost every demand. Convectors are orificed for use as a component of low pressure, two pipe systems of steam heating, either vacuum or open return. They cannot be used with hot water heating or one pipe steam systems.

Reconditions Worn Threading Dies

No. 3561—A reconditioning and regrinding service for

Heating Piping & Air Conditioning [10-47]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

3558 3559 3560 3561 3562 3563 3564 3565 3566 3567
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ALDRICH HEAT-PAK PRODUCTS

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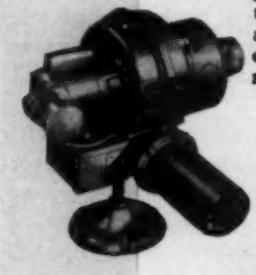
The AX Models cover 90% of all conversion needs in residences and many commercial and industrial jobs. Low-cost interchangeable draft tube assemblies and air cones enable quick modification covering 3 nozzle capacity ranges: AX-1, .75 to 1.35 gph; AX-2, 1.35 to 2 gph; and AX-3, 2 to 5 gph. Various lengths of draft tubes available. You can meet a wide range of customer's requirements with a minimum stock.



The Model BX Burner is a larger size than the AX, covering a nozzle capacity range from 4 to 9 gph.

MODEL BX

MODEL JU

The Model JU Jumbo Burner is a heavy-duty model for larger buildings. It has a ¾-hp motor, and duplex nozzles and ignition. Nozzle capacity range is from 5 to 19 gph.

All Aldrich Burners are shipped complete with automatic controls, as specified, for warm air, steam, or hot water heating plants. Aldrich Products have gained wide and favorable acceptance, largely due to high quality construction that insures peak performance through a long and useful life.

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Made in 6 sizes for hot water heating, steam heating, or hot water supply. Capacities 85,000 to 808,500 BTU per hour. Extremely well-made throughout.

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worn threading dies is offered by the Mechanical Arts Co., 4 Orient Way, Rutherford, N. J.

Dies are cleaned, reground, reconditioned, and are wrapped in sets marked for identification. The service is available on one or any number of dies and is offered on a nationwide basis. Costs are said to be about one quarter that of replacement.

Slide Rule Simplifies Flow Calculations

No. 3562—The new "Flow-Rule" developed by Foxboro Co., Foxboro, Mass., is a specially designed 12 in. slide rule for computing orifice plate bores, flow nozzles or venturi throats, and also the rate of flow, or the differential created across the orifice plate (whether flange tapped or full flow tapped) or other primary device.

It can be used for all fluids, with or without seals, and covers such a wide range of flows and line sizes that it will handle almost any commercial problem. Although its average error is said to be well within the accuracy of flow test data, it is not intended to replace computation methods where purchase and sale of fluids are involved. It will, however, be found to be useful for checking such calculations.

All necessary instructions are on the back. The reversible slide has scales for gas on one side and liquids and steam on the other side, and color is used to distinguish the scales for such fluids. Other color bands are shown, with tick marks indicating the ID of Schedule 30, 40, 80 and 120 pipe.

Heat Transfer Tube Has Integral Extended Surface

No. 3563 — "Wolverine Trufin" is an extended surface type heat transfer tube having fins which are extruded from the tube itself. Designed for many commercial and industrial applications including heating, refrigeration, and air conditioning, it is offered by Wolverine Tube Div., Calumet and Hecla Consolidated Copper Co., 1411 Central Ave., Detroit 9, Mich.

Outstanding advantages are said to include high heat transfer and the ability to withstand vibration and extreme temperature changes. The tube is made in various fin spacings, fin heights, and is available in copper and aluminum.

According to the manufacturer, the inside diameter is closely controlled so that inserted end connections can be made by brazing any standard tube into the finned tube.

Cast Iron Construction Used in Baseboard Panel

No. 3564—Type R radiant baseboard panel and Type RC radiant-convector panel have been announced by

Power Plant Expansion Requires Varied Pipe Welding

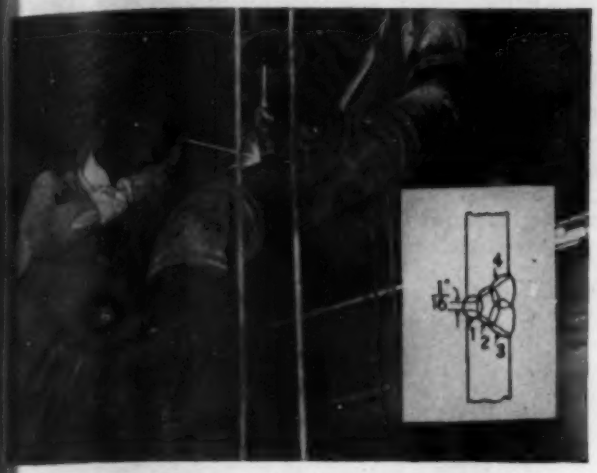


Fig. 1. Welding suspension cylinder to 8" steam line. Pipe joints were welded as shown in sketch.

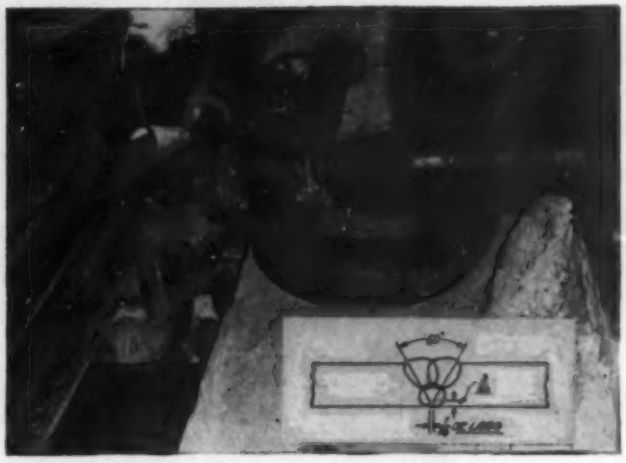


Fig. 2. Welds in these 6" and 4" horizontal pipes were made as shown in sketch.

By William P. Miller, Engineer
Smith & Oby Co., Heating Contractors
Cleveland, Ohio

The municipal light plant at Painesville, Ohio, is being expanded by the addition of a new boiler and installation of tie-in lines between the various turbo-generators, pumps and boilers for greater flexibility of operation. Main steam lines will carry 600-lbs. pressure.

All pipe connections are being made by arc welding except where valves and equipment have bolted flanges. "Fleetweld 5" electrode is being used.

Fig. 1 shows the welding of the bracket of a spring suspension cylinder to an 8" steam line. This cylinder permits the movement of the pipe caused by an expansion joint below. The elbows are "Tube Turns." These horizontal welds in 8" vertical pipe were made in four passes, as shown in sketch. Pipe ends were bevelled 30°. Stringer pass was made with 1/8" "Fleetweld 5" electrode and subsequent passes with 5/32" size.

Fig. 2 shows a 6" steam line reduced to 4" with a standard taper. Joints in both the 6" and 4" pipe were made according to the standard procedure for vertical welds in horizontal piping (see sketch), using 5/32" electrode for the stringer bead and 3/16" size for second and third passes. Elbows in both 4" and 6" pipe are "Tube Turns." The "fish-mouth" connection of the 6" lines was laid out by the template method and the pipe, flame-cut to the pattern.

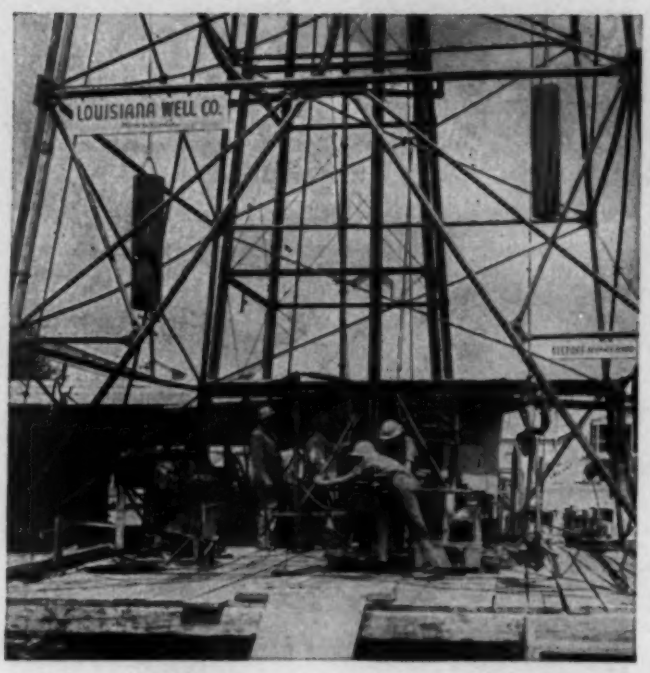
Fig. 3 shows the welding of a 45° elbow to a 3" steam pipe. Since this is extra-heavy pipe, three passes instead of the usual two were made, and the sketch in Fig. 2 again applies 1/8" electrode was used for all three passes.

Fig. 4 shows the bottom of an 8" vertical exhaust line from a warm water storage tank above, with three 4" lines branching off from it. The 1/2" plate on the end of the 8" pipe was welded on with 10 or 12 stringer beads. Joint was bevelled 60° to provide 100% penetration. The drain valve was screwed onto a short length of 2" pipe which was welded to the plate in 3 passes. The 4" pipes were welded to the 8" pipe in four passes, instead of three, for extra strength with 1/8" electrode on the stringer and 5/32" on the remainder. The "fish-mouth" ends of the 4" pipes were laid out to fit the contour of the 8" pipe by the template method.

Fig. 3. Welds in extra-heavy 3" pipe were made in 3 passes.

Fig. 4. A 1/2" plate was welded on the bottom of this vertical 8" exhaust line.

The above is published by LINCOLN ELECTRIC in the interests of progress. Specifications and procedures for "Fleetweld 5" electrode are given in Bulletin 403. Write The Lincoln Electric Company, Department 473, Cleveland 1, Ohio.



4 LAYNE UNITS FOR WEST MONROE, LA.

The city of West Monroe, Louisiana will soon have four complete Layne Well Water Supply units and an adequate supply of water to fulfill the needs of a growing and thriving oil metropolis. The first two were bought on confidence in the name Layne . . . but the third and fourth purchases were based upon known knowledge of how Layne Well Water Systems perform.

West Monroe city officials know the cost of operating these systems, how they keep steadily on the job with little or no upkeep cost . . . and how they fulfill every claim made by Layne.

Layne Well Water Systems are engineered and built to serve cities, factories, chemical plants, railroads, packing plants and air conditioning and irrigation projects. They have the extra ruggedness of quality and precision type of construction that gives complete satisfaction.

If you are in need of more water, Layne Engineers will gladly make valuable and dependable recommendations. For literature address

LAYNE & BOWLER, INC.
General Officers:, Memphis 8, Tennessee

● **pumps** for wells, lakes, rivers, reservoirs, irrigation —or for any use where large quantities of water must be produced at low cost. Sizes range from 40 to 16,000 gallons per minute. Write for Layne Pump Catalog.

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vertical turbine pumps

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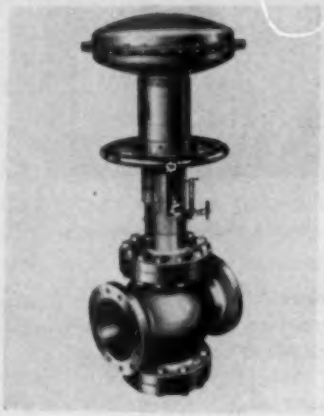
American Radiator & Standard Sanitary Corp., P.O. Box 1226, Pittsburgh 30, Pa.

The panels are 8 in. high, 2 in. thick, and are made in lengths of 12 and 24 in. They are designed to fit snugly against the wall or may be partially recessed. When recessed, they fit into the wall to the depth of the plaster, projecting a little more than an inch into the room. According to the company, the panels may be used in place of the wood baseboard. Special valve enclosures and matching corner covers are furnished so that all piping and valves are readily accessible. The panels are made of cast iron, are constructed with a cast-in supporting lug on either left or right end, and a center section is available without end support.

Provides Manual Operation for Control Valves



No. 3565—A continuously connected handwheel valve designed to operate its control valves manually has been developed by Hammel-Dahl Co., 243 Richmond St., Providence 1, R. I.

The unit, which may be applied to any of the company's valves, 2 in. through 12 in. size, is said to eliminate the necessity for providing a bypass and globe valve arrangement for emergency manual operation. The new unit is designed to operate the control valve manually regardless of maximum instrument air pressure on the diaphragm or in opposition to the spring.

The valve plug may be positioned by hand under any conditions, and in addition, travel limit stops are incorporated to limit the valve stroke from 0 to 100 per cent. For example, these stops can be set to permit a 25 per cent travel located at any point in the stroke from fully closed to fully open. With this arrangement, when the valve is on automatic control, the handwheel and stops are adjusted so that valve can operate freely about the average plug position. Should any failure of air to the controller occur, or the air line from the controller to the control valve be broken, the control valve plug could change its position only 12½ per cent. In this emergency, the operator could properly position the plug by turning the handwheel which could also be used to block the valve plug wide open or to shut the valve.

The valve plug position indicator is designed to show the valve plug position, the setting of the travel stops, the per cent travel of the plug, and in what portion of the stroke the free travel can occur. It also shows whether the handwheel is in a neutral position.

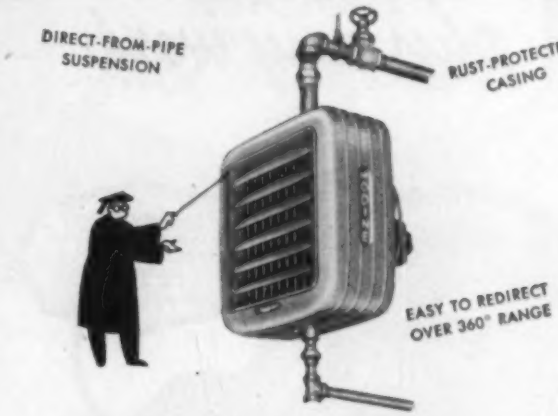
To Manufacture Oil Burners, Boiler Units

No. 3566**—"Everedy" and "Oiltronic" oil burners and burner-boiler units are now in production at the plant of the newly organized Mt. Hawley Mfg. Co., Inc., Peoria, Ill.

Five models of oil burners will be offered, ranging in size from ¾ to 20 gph consumption of fuel oil, while

Want a Yardstick for Selecting Unit Heaters?

1. How do coils measure up? No screwed or expanded joints. No gaskets or bolts. Modine's controlled brazing process eliminates weak spots, provides one-piece integrated construction that means greater strength, longer life, better performance.



2. What about suspension? Modine users report installation savings up to $10 per unit. Patented center supply and return connections mean unit can be suspended directly from supply line with complete safety. No expensive supports. No extra labor costs.

3. Is power up to par? A motor must meet rigid performance requirements before it can team up with a Modine unit heater. Only heavy-duty, totally enclosed, nationally known makes are chosen. Rubber mounted, noised-proofed for hush-hush service.

4. Why not get the answer? See how Modine Unit Heaters can meet your space-heating needs! Send coupon today for free Modine catalog jam-packed with diagrams, pictures, specifications, installation ideas, etc. Get this valuable addition to your technical library!

MEASURE the Job and Meet the Need!

When you buy Modine, you buy an extra dash of beauty — a host of features that make it *the* quality unit heater. Choose from three types with 47 basic capacities: 1) Horizontal Delivery Type for general applications. 2) Vertical Delivery Type for overhead use. 3) Power Throw Type for special high velocities. Look for Modine's representative in the "Where-to-Buy-it" section of your phone book, or send in coupon at right.

MODINE MANUFACTURING CO.
1509 Dekoven Street
Racine, Wisconsin

YES! I want all the facts about Modine's integrated Unit Heater Line. Please send me 52 page catalog.

NAME.....

ADDRESS.....

CITY.....STATE.....

Modine UNIT HEATERS

PIPE WRENCH
ECONOMY
plus easy work
UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free
COPR. 1951 THE RIDGE TOOL CO. ELYRIA, O.
TRADE RIDGID
Only
RIDGID
pipe wrenches
give you these
5 valuable features
1) Housing guaranteed against breakage or distortion — no repair expense, ever; 2) Adjusting nut in open housing spins freely in all sizes; 3) Handy pipe scale on hookjaw; 4) Instant-action non-slip non-lock jaws; 5) Powerful comfort-grip I-beam handle. All this adds up to fast, easy work and real pipe wrench economy, too. RIDGID heavy-duty pipe wrenches, sizes from 6" to 60," are available at your Supply House.
RIDGID
strap wrench won't mar polished pipe or tubing.
RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

seven boiler units will range from 350 to 3500 EDR steam. According to the company, volume production has been attained on several models for contract purchasers, and units are now being supplied to distributors and dealers. A newly completed modern factory and office building is said to include excellent facilities and its location provides unusual air, rail, and truck service.

Two Stage Air Compressors Air-Cooled

No. 3567—A new line of two stage, air-cooled stationary air compressors has been developed by the Sullivan Div., Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa. These "Unitair" compressors are available in nine sizes from 15 to 100 hp.

Designed for 100 psi discharge pressure, the units are offered in three standard 60 cycle electric motor drives: built-in motor, direct-connected motor, and v belt drive. The compressors may also be equipped with gasoline or diesel engines. Outstanding features are said to include forced feed lubrication through riffle-drilled oil passages by means of a gear pump, "Cascade" oil cooling designed to reduce oil consumption, concentric valves of large port area having low lift, low piston speeds, and oversize ball type main bearings.

Draft Gage Warns When to Change Filters

No. 3568—Owens-Corning Fiberglas Corp., 1911 Nicholas Bldg., Toledo 1, Ohio, manufacturer of "Dust-Stop" air filters, is supplying a new draft gage to distributors for use by their commercial and industrial customers in determining when air filters should be replaced.

Pumps Handle Large Volumes of Water

No. 3569—"Mixed Flow" type pumps, which are designed to provide advantages of both axial flow and centrifugal pumps, are now available to industrial and agricultural users for handling large volumes of water. The manufacturer is Peerless Pump Div., Food Machinery Corp., 301 West Ave., 26, Los Angeles 31, Calif.

Outstanding advantages of these pumps are said to be their ability to move water at maximum heads with minimum submergence, permitting the use of shallower sumps and higher speed motors for medium heads. Capacities range from 600 to 220,000 gpm at heads from 2 to 60 ft., and both single and multi-stage units are offered.

Measures Water in Fuel Tanks

No. 3570—The "Waterwitch" is offered by the Motor parts Mfg. Co., 701 McCarter Highway, Newark 5, N.J., as a simple, inexpensive device for measuring in inches the actual amount of water in tanks storing fuel oil, gasoline, and similar liquids.

The unit is constructed of brass, has a neoprene seal

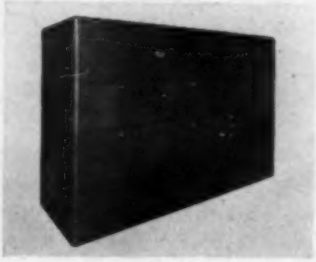
nd a glass gage, and is attached to the end of a tank tick.

mproved Transmission Among eatures of New Stoker

No. 3571—A new line of domestic, commercial, and ndustrial stokers in a complete range of hopper and in-feed models has been announced by Freeman Stoker Div., Illinois Iron & Bolt Co., 918 S. Michigan Ave., Chiago 5, Ill.

New engineering features include a new cone gear rive transmission which has only two precision-cut ears, variable speed pulleys, a permanent mounted an and housing designed to form a complete assembly equiring no adjustments, automatic air control, and n extended windbox surrounding coal tube and retort. opper type commercial and industrial models range p to 750 lb per hr capacity.

ses Control to Prevent Compressor Short Cycling



No. 3572—The new "ASC ontrol" is now being inalled in all refrigerated Kooler-Aire" units of the nited States Air Condioning Corp., Como Ave., .E., at 33rd., St., Minneapolis 14, Minn.

The new control is deigned to permit the compressor to start only when the hole system is in operation in response to the space hermostat. The packaged refrigeration units, shown ere, are available in sizes up to 40 tons and are offered or use in commercial and industrial installations.

il, Gas, or Coal Used ith New Water Heater

No. 3573 — The Heat Equipment Co., 1020 E. 75th St., Chicago 19, Ill., has announced a new line of domestic and industrial water heaters in capacities ranging from 60 to 720 gph at 100 F temperature rise. Either oil, gas, or stoker-fired fuel may be used with the heaters, the largest of which has a 33 in. diameter base. Heights of units vary with capacities.

The use of a "balanced flow" water heating prinple is said to trap heat, eliminate "flues", and provide igh efficiency.

A line of instantaneous water heaters will also be ffered in capacities from 3 to 6 gpm at 100 F temperture rise.

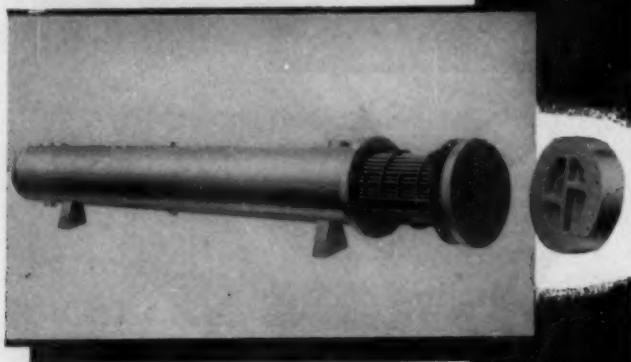
riction Clutch Developed or V Belt Drives

No. 3574**—A new "Ball-lok" v belt friction drive utch has been announced by the V-Belt Clutch Co., 57 Wilshire Blvd., Los Angeles 5, Calif.

PIPE REAMING
NOW MADE
fast, safe, easy
RIDGID
The
RIDGID
extra-long-taper
does the trick—saves
you time, muscle and pipe
● You ream pipe fast and easily with this extra efficient long-taper RIDGID reamer. Long-taper prevents thinning, flaring or splitting pipe or conduit. Even on hurried work you whisk out burr cleanly with a few light ratchet strokes, leaving pipe clean and unmarred. Comes complete with ratchet handle — or will fit your RIDGID No. 00R threader handle. Save pipe, time and work. Buy it at your Supply House.
Reamer unit alone may be bought for your RIDGID No. 00R threader handle.
RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY · ELYRIA, OHIO

PATTERSON-KELLEY
Heat Exchangers
AND
Process Equipment

Heat-Transfer
SPECIALISTS



Specializing
IN REFRIGERANT
COOLERS

The very essence of "air conditioning" is the controlled transfer of heat.

It was entirely logical, therefore, that Patterson-Kelley engineers, who have specialized for years in heat-transfer equipment, should turn their attention years ago to refrigerant coolers, condensers and other heat-transfer equipment needed in air conditioning and refrigeration systems.

Today, Patterson-Kelley Equipment, coolers for example, is considered by many to be the standard for such installations.

THE PATTERSON-KELLEY Company, Inc.
107 WARREN STREET, EAST STROUDSBURG, PA.
NEW YORK 17—101 Park Ave. PHILADELPHIA 3—1700 Walnut St.
CHICAGO 4—Railway Exch. Bldg. BOSTON 16—96-A Huntington Ave.
Representatives in Principal Cities

Designed to grip or release directly on v belts, units, complete in themselves, may be used either as driving or driven pulleys. In operation, the clutching action is the grip of the sidewalls of the pulley against the belt. When the clutch is opened, the belt slackens and idles on a free-running, grease sealed, ball bearing. One fixed flange of the belt sheave is an integrally attached part of the hub and the inner race of the sealed ball bearing belt idler.

Four sizes in the present line have 3¼ to 5 in. sheave diameters, and are 2 15/16 to 3 1/16 in. overall length. Two may be applied to ¾ in. shafts; two to 1 in. shafts. Heavier duty multi-belt units will soon be available.

Flux Not Required with Aluminum Solder

No. 3575**—"Alsoco," a new aluminum solder from Switzerland, is being manufactured and distributed exclusively in this country by Alsoco Corp., 10 E. 52nd St., New York City. Fluxes or protective methods are not used.

According to the company, independent laboratory tests have demonstrated a shear strength greater than the aluminum base metal, even after a 250 hr salt spray corrosion test. When used to join aluminum cable to a standard copper lug, as shown here, the solder is said to produce a joint having greater vibration strength than the wire itself with electrical resistance in the range of 20 microhms.

Improves Recording Thermometers and Recording Gages

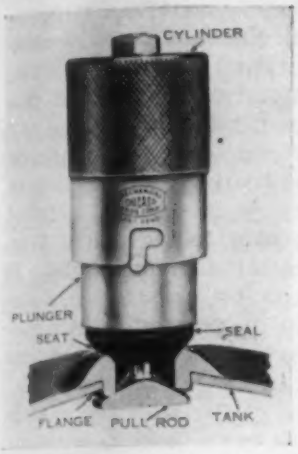
No. 3576—A new line of recording thermometers and recording gages known as the Series 500 line of recorders has been announced by the Bristol Co., Waterbury 91. Conn. These instruments operate on the same basic principles as those used in recording thermometers and gages built by the company for many years. They are, however, housed in a new, modern case and are said to incorporate many design improvements.

The case is designed so it can be mounted either on a wall, front of panel, or flush on a panel and can be converted by the user from one type of mounting to another.

Pen arms are pivoted on stainless steel journals with the pen arm shaft supported at both ends in a rigid one piece mounting. The journals are ground and polished to provide low-friction action. Link members between the measuring element and pen arm mechanism are readily removable without tools and can be equipped with over-range and under-range two way springs when

required. Improvements are said to have been made in the measuring element for greater accuracy and for ease in adjusting. Units are furnished in 8 in. and 12 in. sizes in a wide variety of ranges.

Seals Low Pressure Tanks During Testing, Provides Filling Connection



No. 3577 — Mechanical Products Corp., 168 N. Ogden Ave., Chicago 7, Ill., has announced the "Hydro-Matic" self-sealing test plug for use in closing openings in low pressure tanks, boilers, or other vessels requiring hydrostatic or pneumatic internal pressure tests.

The plugs are designed for any type of spudded, flanged, or drawn opening, either plain or threaded, are available for openings from ⅛ to 4 in., and are suitable for testing pressures up to 100 psi. A compression spring retains the plug in position while the inside tank pressure is utilized to actuate the plunger which holds the seal against its seat.

The company's self-sealing filling connections are similar devices for adapting air or liquid pressure lines to tanks, boilers, vessels, etc. which are to be tested by internal pressures up to 500 psi. These are adaptable to pressure lines from ⅜ to 1 in. size and for pipe flanged openings from ¾ to 1½ in.

Small Motor Serves Many Uses

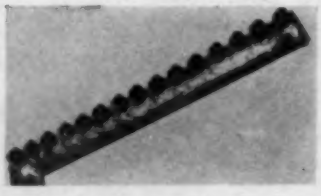
No. 3578**—The Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y., has announced a 14 oz series universal motor, Unit 597, for household, commercial, and automotive electrical appliances.

The motor can be wound for ratings of 1/20, 1/40 and 1/70 hp at 117 volts, and for 6 volt operation. Overall dimensions are 3¼ by 2 7/32 in. The 1/20 hp motor is available for immediate delivery; the others under special order.

The 1/20 hp motor is rated at 4.0 in.-oz torque at 12,700 rpm, for a 56 C temperature rise on a one hour duty cycle.

Among the many applications for which units are offered are desk fans, small exhaust fans, window ventilators, churns, agitators, unit and space heaters, display mechanisms, damper controls, actuator or cycling mechanisms, pumps, fans, etc.

Brazing Rod Offered for Copper-Bearing Alloys



No. 3579**—The No. 23 phosphor-copper-silver brazing rod developed by All-State Welding Alloys Co., Inc., 96 W. Post Rd., White Plains, N.Y., is offered for use on all copper-bearing alloys.

YOU CAN GET IT QUICKER FROM

STEWART

QUICK FACTS ABOUT HIGH VELOCITY OUTLETS MADE BY STEWART

The styles illustrated are typical examples of improvements in the Stewart line of Outlets, Wall and Baseboard Registers, Scoopaires and Radiator Fronts. All have been redesigned for smarter appearance, better diffusion and more flexible adjustment. The Stewart line is competitively priced and includes a wide range of popular types and sizes of outlets for air-conditioning, heating and ventilating. Special types and sizes can be made to your specifications.

PROMPT DELIVERIES ON STANDARD SIZES

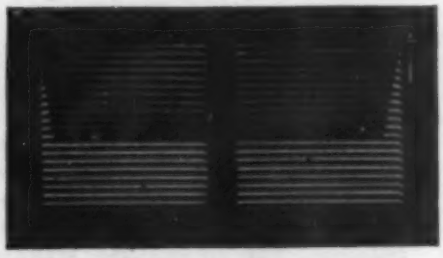
STYLE DDV

(2 Banks) Individually Adjustable Face and Rear Bars

Style DDV is one of 8 variations of Stewart High Velocity Outlets. By means of a detachable key, all bars are adjustable for directing air straight and at various right-left or up-down angles. Style DDV has vertical face bars and horizontal rear bars. Style DDH (not shown) has horizontal face bars and vertical rear bars. This type of outlet is made in popular sizes with or without lever-operated, multiple volume valves. Matching intakes are available. OUTLETS CAN BE SUPPLIED TO FIT CONTOURS OF CABINETS FOR ROOM COOLERS.

STYLE 91

Lever-operated Single Damper Wall Register



STYLE 91 is from the series 70-90 of Wall and Baseboard Registers made with single dampers, or multiple-valve dampers, both lever operated. Face bars of the 90 series are horizontal and set down at a 22 degrees angle. Face bars of the 70 series are vertical, set straight. Setting keys are furnished for user to alter bar settings. Matching, fixed bar grilles are available.

Send for literature and prompt quotation on your requirements

STEWART MANUFACTURING COMPANY
INCORPORATED
610 Bloomfield Avenue — Bloomfield, N. J.

The job shown here consists of 15 low temperature, welded joints on a copper manifold assembly. Each joint was heated to 1270 F using a neutral or slightly excess-acetylene flame. Because of the capillary action of the alloy, the rod was applied at a single point on each joint.

New Wedge Gate Valves Have Iron Bodies

No. 3580—The new line of standard iron body, wedge gate valves developed by Walworth Co., 60 E. 42nd St., New York 17, N.Y., is recommended for steam pressures up to 125 psi and for water, oil and gas pressures up to 200 psi. The valves may be obtained in the nonrising stem type or the outside screw and yoke type, with screwed or flanged ends as desired. In addition, all-iron valves or iron body, bronze mounted valves may be obtained.

The NRS type valves have bronze stem thread bushings in the discs and the all-iron valves have nickel plated steel stems, integral disc faces, and renewable screwed-in seats. The NRS type units are offered in sizes from 2 to 16 in. and the outside stem and yoke type is available from 2 to 24 in. size.

Designs Draft Gage for Heating Plant Use

No. 3581—Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh 8, Pa., has introduced a new, all purpose draft gage, Model MZF, designed primarily for installation and service work on every type of heating plant. This gage is supplied with 9 ft of rubber tubing and a 5 in. metal sampling tube. It can be used for readings at the point of draft measurement or for remote readings when adjusting burners.

Among the design features of the unit are a large area diaphragm enclosed in a metal housing, unusual readability, free movement of the pointer at zero to indicate "puff-backs," and the body which serves as a reel for carrying rubber tubing without kinks.

Unit Cooler Defrosted with Tap Water

No. 3582—In announcing its new water defrost unit coolers for low temperature applications, Tenney Engi-

MASTER FLO-CONTROLS FOR POSITIVE AND ACCURATE MANUAL OR AUTOMATIC FLO-TEMPERATURE CONTROL

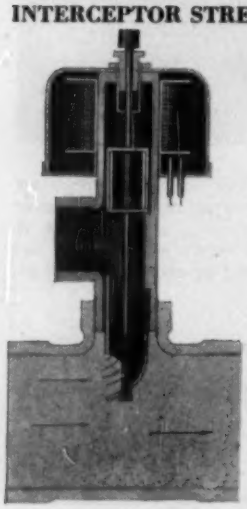
Temperatures as desired can be secured in each separate zone. Zoning of all or parts of panel heating coils, mains or risers can be accurately done with thermostatic operated MASTER ZONE-CONTROLS.

Circulation for temperature balance can be secured throughout the heating system with emersion operated MASTER ZONE CONTROLS.

With the use of MASTER FLO-CONTROLS no changes occur in the pumping head to change the static balance of other branches of the circulating system as takes place with the use of PUMPS FOR ZONING.

MASTER FLO-CONTROLS ARE NOT VALVES

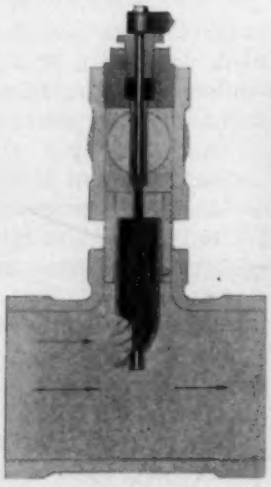
The MASTER FLO-CONTROLS operate with the PATENT MOVING INTERCEPTOR STREAMLINED TUBE that intercepts the flow, directing same without loss through the tube into the branches resulting in 100% diversion with less friction than required for conventional pipe tees.



The MASTER FLO-CONTROLS are not valves or fittings with flat pedal interceptors that allow the flow to slip out over the sides of the interceptors, but are streamlined interceptor tubes.

The ZONE-MASTER regulates the flow thru the streamlined interceptor tube operated by a solenoid or motor under the control of a thermostat or emersionstat.

Flow distribution thru the ZONE-MASTER can be manually adjusted during circulation for balanced temperature circulation.



The FLO-MASTER regulates the flow thru the streamlined interceptor tube by manual adjustment during circulation for balanced temperatures.

Changes in the desired temperatures can be made by manual adjustment during circulation.

•

MASTER FLO-CONTROLS ARE INSTALLED IN CONVENTIONAL PIPE TEES ELIMINATING LARGE STOCKS OF SPECIAL FITTING.

•

MASTER FLO-CONTROLS built with the intereceptor streamlined tube ELIMINATES ALL WATER NOISES caused by special fittings with fixed partitions, jet pipes, valve interceptors and other obstructions to the flow of water that result in high circulating pressures.

The W-H Engineering Company

4102 S. La Salle St. **Chicago 9, Ill.**

neering, Inc., 26 Avenue B, Newark 5, N.J., emphasizes ease of installation and the minimum servicing required.

Made in three sizes with capacities from 4400 to 14,000 Btu per hr at 15 deg temperature difference, the units are designed for defrosting in a few minutes with ordinary tap water. Each unit is equipped with adjustable louvers, standard IPS water connections, and the company's TS-1 thermostatic expansion valve.

Rubber, Steel Spring in Vibration Control Unit

No. 3583—A new low cost vibration control unit, the Type RS conical rubber-spring mounting, has been announced by the Korfund Co., Inc., 48-36 32nd Pl., Long Island City 1, N.Y. Designed for a load capacity ranging from 25 to 125 lb per unit, the conical spring design is said to provide greater horizontal stability than conventional all-rubber mountings, smooth operation, particularly during starting, and frequently to eliminate the necessity for snubbers or flexible connections.

This combined use of rubber and steel springs not only increases the load capacity but, says the manufacturer, also gives a wide frequency range for successful isolation so that it is equally effective for pumps operating at 1750 rpm, as well as compressors running at 450 rpm. The new unit has been designed primarily for use on compressor units, generator sets, motor generators, pumps, motors, fans, and other machinery.

New Fuel Control Used on Oil Burners

No. 3584—Iron Fireman Mfg. Co., 3085 W. 106th St., Cleveland 11, Ohio, has announced a new principle of heavy fuel oil control.

In the company's new series of industrial heavy fuel oil burners it is used to stabilize the feeding rate of fuel, regardless of changes in fuel oil temperature or viscosity.

The new burners have capacities from 8 to 125 gph and are said to deliver the same quantity of oil, no matter how thick or thin, and to feed evenly at the maximum burning rate or throttled down to low capacity. No regulating valve or viscosity compensating device is used.

Regulates Flow of Water in Heating Systems

No. 3585**—The thermostatic "Flo-Controls" of the W-H Engineering Co., 4102 S. La Salle St., Chicago 9, Ill., consist of patented moving streamlined interceptor tubes adjustable for balanced regulation. They are designed to control temperatures in various zones or

NOTE: this message will interest plant and consulting engineers who know that an air-conditionig system is no better than the pumps employed!

where EFFICIENCY!...ECONOMY! ...and DEPENDABILITY!...count!

A WEINMAN PUMP IS THE HEART OF THE AIR-CONDITIONING SYSTEM!

What greater proof of quality can any pump offer than its on-the-job performance record? . . . and the WEINMAN pump record for day in and day out *Dependability!* . . . *Efficiency!* . . . and *Economy!* . . . as the heart of countless air-conditioning systems, is a record to convince you that *Weinman Pumps Are "Right" For The Job* . . . made right by centrifugal specialists who know air-conditioning pump requirements.

WEINMAN
TYPE "G" UNIPUMP

Especially adapted for circulation of chilled water or brine. Sizes to provide capacities of 10 G.P.M. to 1000 G.P.M., heads to 500 ft., and motor ratings ranging from ½ hp. to 30 hp.

CENTRIFUGAL SPECIALISTS

WEINMAN
PUMP MFG. Company

COLUMBUS · 8 · OHIO

parts of a heating system by regulating the amount of water circulation.

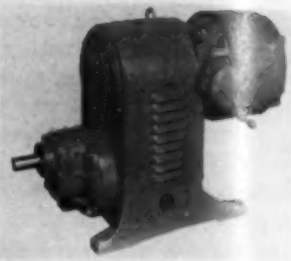
The units are said to eliminate swishing and gurgling noises and to introduce relatively little resistance to flow when maximum flow is required. They are installed in conventional pipe tees, each branch size operating in any size main.

Damper Motor Features Quiet Operation

No. 3586*—A new motor designed primarily to control the draft and check dampers on hand-fired heating systems, and mounted on rubber grommets for quiet operation is ready for immediate delivery from Gleason-Avery, Inc., Auburn, N. Y. Designated as No. 315, it is the rotating arm type, having a three wire control circuit.

The company asserts that unique construction features of the motor result in sustained full powered operation for an unusual length of time. Bearings are oil-retaining porous bronze. A hand switch permits manual operation of the dampers during firing periods. The unit operates on 20 volts, 50-60 cycles. Maximum load at extreme radius is 20 lb.

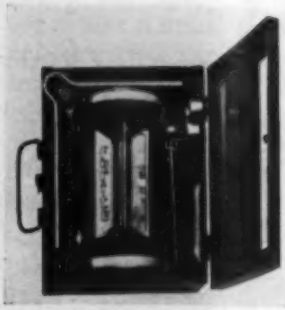
Variable Speed Drive Has Many Applications



No. 3587—First of a new series of "Varidrive" variable speed drives, designated as Size 23, has been announced by U.S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles 54, Calif.

A widespread variety of assemblies is available to fit almost any application, such as horizontal frame with shaft left or right, upright frame with shaft high or low, and built-in speed reducers of single or double reduction. Speed variations of 2:1 to 7:1 are obtainable with up to 5 hp output.

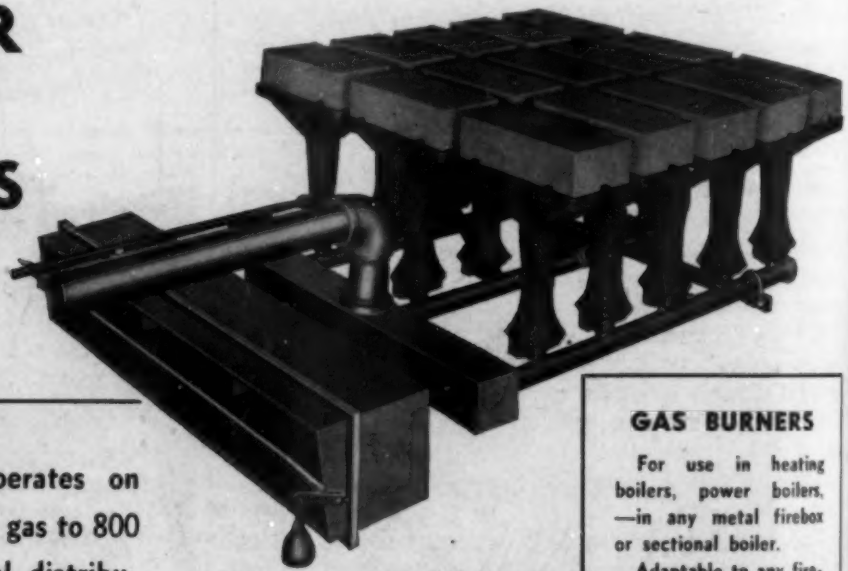
Combustion Service Kit Has Dial Thermometer



No. 3588—Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa., has developed two new features for the "Fyrite" combustion service kit. A metal case with metal handle and snaps is now standard equipment. An all-metal dial thermometer, 100 to 950 F range, is

WEBSTER
Series F600
GAS BURNERS

50,000 to
10,000,000 Btu.



The Series F600 Burner operates on straight natural gas and mixed gas to 800 Btu. Gives perfect horizontal distribution. Fully automatic controls—that operate properly—can be easily applied.

Write for new illustrated Catalog of Webster Burners and Controls.

GAS BURNERS

For use in heating boilers, power boilers, —in any metal firebox or sectional boiler.

Adaptable to any firebox shape or size.

Handles various gas pressures and effects low draft loss.

THE WEBSTER ENGINEERING CO.

— DIVISION OF —

Surface Combustion Corporation . . . . . Toledo, Ohio

TULSA OKLAHOMA

optional equipment in place of the mercury-in-glass thermometer.

Advantages claimed include easy readability, even in dim light, handling convenience, and the elimination of breakage hazards.

Copper Dehydrators Again Available

No. 3589—Announcement has been made by Cyrus Shank Co., 625 W. Jackson Blvd., Chicago 6, Ill., that its copper dehydrators are now available after an absence of several years.

Made in two sizes (2 in. OD and 1 in. OD) and provided with felt screens and filters, the units are said to give trouble free service. The larger unit is made with forged brass flare fittings. The smaller unit is of copper tubing with spun ends.

Tightening Fitting Flares Tubing

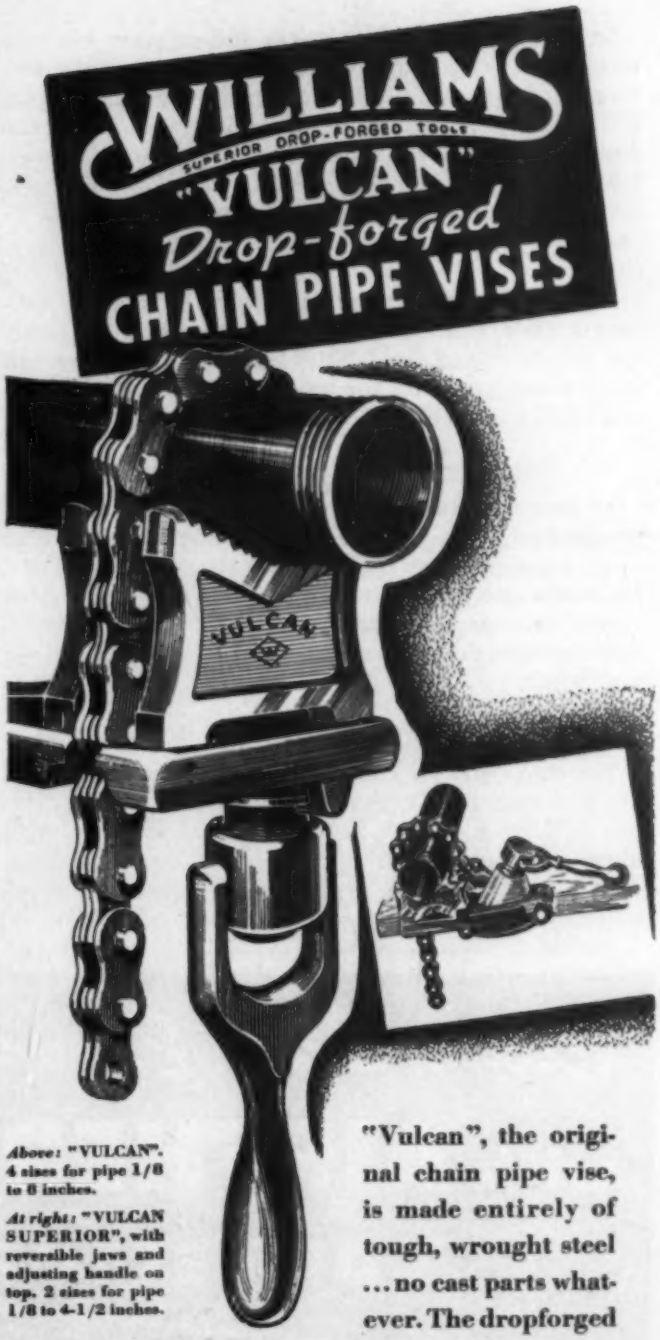
No. 3590—The "Everseal Self-Flaring" fitting is designed so that ends of tubing are forced into a recess in the fittings and tightening of the nut completes a double seal. The line of standard compression, SAE flared, inverted flared, and other connector fittings is offered by Everhot Products Co., 2001-9 W. Carroll Ave., Chicago 12, Ill.

Fittings are forged from high copper content brass or are fabricated from extruded bar and may be used with "Bundyflex", copper, aluminum, monel, and annealed steel tubing. The manufacturer states that connections may be disassembled as often as desired.

Equipment Shorts

A new respirator incorporating a new dust filter for protecting industrial workers exposed to poisonous and disease-producing dusts smaller in diameter than 24 millionths of an inch has been announced by American Optical Co., Southbridge, Mass. First of its kind, the new filter consists of a felt which has been chemically treated so that its ability to prevent the passage of dust is said to be 40 times greater than untreated filters. Approved by the U. S. Bureau of Mines, the new AO R-2000 respirator and filter is designed to protect workers against toxic dusts such as lead, cadmium, arsenic, chromium, etc.; pneumoconiosis-producing dusts, free silica and asbestos; and the nuisance dusts, iron ore, coal, coke, aluminum, limestone, etc.

Official approval has just been granted by the American Gas Association for the use of liquefied petroleum gas in all "Janitrol" gravity furnaces and winter air conditioners at full catalog ratings, according to a recent announcement from the manufacturer, Surface Combustion Corp., Toledo, Ohio.

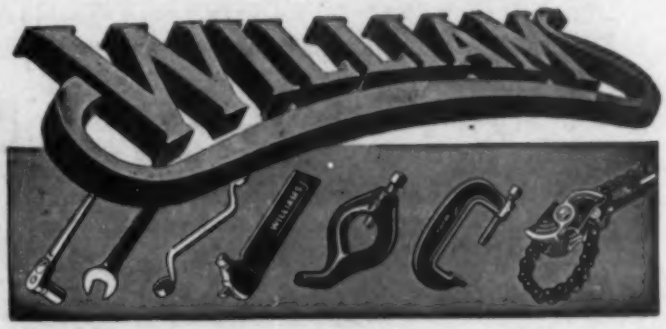


Above: "VULCAN". 4 sizes for pipe 1/8 to 6 inches.

At right: "VULCAN SUPERIOR", with reversible jaws and adjusting handle on top. 2 sizes for pipe 1/8 to 4-1/2 inches.

"Vulcan", the original chain pipe vise, is made entirely of tough, wrought steel ... no cast parts whatever. The dropforged jaws are of saw-tempered steel for file sharpening ... chains are of the same high quality as Williams' "Vulcan" Tongs. Fully guaranteed, and sold by Industrial, Plumbing and Oil Field Distributors everywhere.

J. H. WILLIAMS & CO., BUFFALO 7, N. Y.



In an effort to stabilize prices and enhance business relationships all prices quoted by the Fairbanks Co., New York City, have been on a firm basis since August 25. Products included in the new price policy are bronze and iron body valves, including "Sphero" valves and asbestos-packed cocks. Prices quoted are now subject to acceptance within 15 days from date of quotation.

The first motors to be manufactured in the new Ashtabula, Ohio, plant of the Reliance Electric & Engineering Co., Cleveland, are off the assembly lines. The new plant is being used for the production of 1 to 15 hp electric motors and drives.

An improved line of redwood cooling towers is now in production at the plant of Nulco Fabricators, according to an announcement from Refrigerating Machinery Co., 525 Market St., San Francisco 5, Calif., sole distributors. Ample supplies of graded materials are said to be on hand so that delivery can be made in all sizes and for any capacity.

The C. A. Woolsey Paint & Color Co. Inc., 229 E. 42nd St., New York 17, N.Y. has developed and is now marketing new types of protective coatings called the "Metalast" system of painting. These paints contain new resins and are used in preventing the corrosion of industrial equipment and the corrosion and fouling of ships' bottoms. Strong adhesion to all types of metals, high resistance to abrasion, and impervious properties of the coatings are among the chief advantages stressed by the manufacturer. A "Washcoat" primer is applied as a single coat and serves as an anchor for subsequent coatings on steel, aluminum, galvanized iron, stainless steel, and alloys. Two or three coatings of "Anti-Corrosive" are used to provide a tough barrier coat with tight inner coat adhesion. This is said to be highly resistant to exterior corrosive elements. Third and last, the "Top Coat" is applied according to the desired color and usage. A clean steel surface is the only requirement for surface preparation. The manufacturer states that the coatings have withstood 100 per cent humidity inside air conditioning systems for 10 months without any sign of edge corrosion.

ASTM Meeting Scheduled

The American Society for Testing Materials, 1916 Race St., Philadelphia, has announced that the 1948 annual meeting will be held in Detroit during the week of June 21-25, and in conjunction with this will be the Eighth Exhibit of Testing Apparatus and Related Equipment. Several Detroit hotels will cooperate, but headquarters will be at the Book-Cadillac. The 1948 committee week and spring meeting will be held in Washington, D. C., during the week of March 1-5.

Clean, Safe, Economical HEATING with AIRTHERM CONVECTORS

AIRTHERM CONVECTORS for hot water and steam heating systems provide the desirable combination of convection and radiant heating. The attractive cabinets can be readily finished after installation in any color to harmonize with interior decorations.

AIRTHERM CONVECTORS are available in four cabinet styles—free standing, partially recessed, wall cabinet, and sloping top wall cabinet—in a complete range of depths, heights, and lengths.

Have you recently investigated the advantages of specifying and installing convectors? Write for new bulletin describing AIRTHERM CONVECTORS.

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Order NOW for immediate delivery. Don't risk Fall shortages. Write for Catalog MTH

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TIME

PROVES

Galvanized (ZINC-COATED) Sheets Stay Stronger Longer

34 YEARS . . . Erected in 1913, and covered with heavy gauge galvanized sheets, this Tennessee concentrating plant of the A/Z Company, pictured at left, is still in excellent condition after more than three decades of service. Painted with Gray Metallic Zinc Paint in 1932.

50 YEARS . . . The galvanized metal roof on this old Missouri farm building has outlasted the building itself, and is still in good condition after half a century of service. Industry and the farm have long depended on galvanizing to protect iron and steel against costly rust. Builders know that as long as iron or steel is zinc covered, it *cannot rust.*

In building for the future, look to the past for proof of a building material's strength . . . durability . . . service. With *galvanized* (zinc-coated) roofing and siding you get the strength of steel . . . the rust protection of Zinc. So for low-cost, long-time service choose the building material that's proved by TIME itself . . . galvanized sheets. Send coupon for information about Zinc and how it helps keep buildings and equipment *stronger longer.*

ZINC INSTITUTE 2 OZ. COATING SEAL OF QUALITY

This "Seal of Quality" is your guide to economy in buying galvanized sheets. Sheets bearing it carry at least 2 oz. Zinc per sq. ft.

American Zinc Institute

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FREE BOOKLETS!

Send me without cost or obligation the illustrated booklets I have checked.

- ☐ Repair Manual on Galvanized Roofing and Siding
- ☐ Facts about Galvanized Sheets
- ☐ Use of Metallic Zinc Paint to Protect Metal Surfaces

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Address_____

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PIPE VISE
AND WORKBENCH
all in one!

You can easily
carry this RIGID
Tristand Vise from job to job

This popular Tristand is more than a pipe vise. It's a convenient tip-proof work bench, too. Tool-steel LonGrip jaws provide firm hold—won't mar polished pipe. Extra work-saver features are three pipe benders that won't flatten pipe, special rim slots for hanging tools, a pipe rest and plenty of space for dope pot and oil cans. Yoke vise, 2½" capacity; chain vise for pipe to 4." Order from your Supply House.

Legs hinged to fold in and chain for easy carrying.

RIGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

EXECUTIVE CHANGES

At a recent meeting of the board of directors of the Taylor Instrument Cos., Rochester, N.Y., H. J. Noble, vice president and treasurer, was elected executive vice president and assistant general manager. He has been with the company since 1907 and will retain his position as treasurer.

Dr. R. C. Mason has been named manager of the electro-physics department of the Westinghouse research laboratories, succeeding G. W. Penney who was recently appointed Westinghouse professor of electrical engineering at the Carnegie Institute of Technology. Dr. Mason has been on leave of absence at the atomic energy project in Oak Ridge, Tenn., for the past year.

Carl Geis and T. E. McDowell have been elected vice presidents of the Pyle-National Co., Chicago., manufacturers of locomotive headlights, turbo-generators, floodlights, and "Multi-Vent" perforated ceiling panels for air diffusion. Mr. Geis, formerly eastern sales manager, will be in charge of sales, and Mr. McDowell, who has been in charge of product design, will be in charge of engineering.

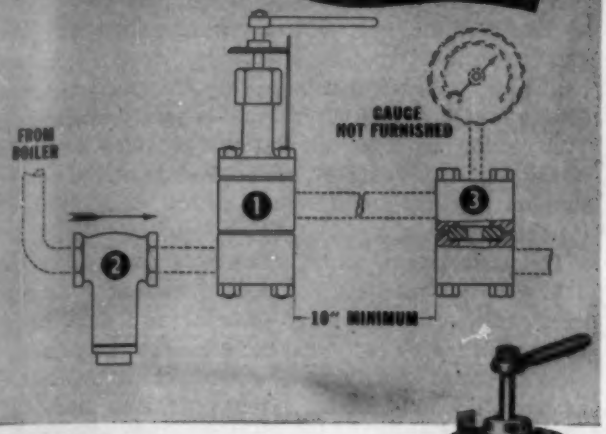
Henry Valve Co., Chicago, manufacturer of a line of solenoid valves, together with valves, dryers, strainers, and accessories for refrigeration and air conditioning, has announced the appointment of G. W. Wheeler as manager of the export department.

Earl Bedard has joined the Aldrich Co., Wyoming, Ill., as chief engineer, according to a recent announcement. His previous experience includes the design and manufacture of oil burning equipment, teaching operation and maintenance of oil burning equipment at the Dunwoody Institute, and instructing air force personnel in the use and maintenance of the electronic automatic pilot.

R-S Products Corp. of Philadelphia, manufacturing engineers, has promoted D. W. Hopkins to executive vice president, giving him full administrative authority in the valve, furnace, and manufacturing divisions. Mr. Hopkins has been with the company since 1939, and directly previous to his new position was in charge of its valve division. His varied experience includes post-graduate work in aeronautical engineering at the Massachusetts Institute of Technology and extensive research work at the University of Pennsylvania, with Professor W. S. Pardoe.

J. K. Rector has been appointed advertising and sales promotion manager of Watson-Stillman Co., Roselle, N.J., manufacturer of hydraulic machinery and mill distributors' products. Prior to his entry in the field of advertising, he served in technical and administrative positions in the fields of petroleum refining, shipbuilding, and machine tool production.

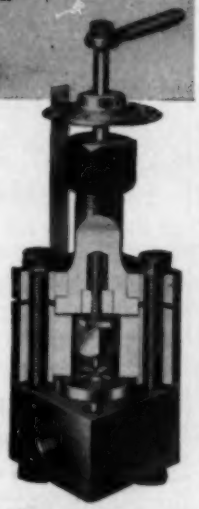
Custom-Built... CONTINUOUS BLOWDOWN



STRONG Dual-Orifice Assembly gives Greater Accuracy . . . Rugged Service!

Strong's Continuous Boiler Blowdown Assembly includes a Strong *block steel* Evrtyte* Valve (1), a strainer (2) and an orifice block (3), *custom-built* and accurately sized for *your own job conditions.*

The assembly is essentially two orifices arranged in series. The first orifice (valve) is variable . . . . the second is fixed. Correct proportioning of orifices provides extremely accurate control and reduces wire drawing.



Also available in outside screw and yoke.

Strong Evrtyte steel valves have special Anum-Metl X† seats and discs of 750 Brinell surface hardness for long life. Available for pressures to 1500 psi and temperatures to 800° F. or 6000 psi non-shock cold service.

Let us custom-size your continuous blowdown system. Send for Catalog No. 102 and our Continuous Blowdown Check-Chart today!

* Reg Trade Mark

STRONG, CARLISLE & HAMMOND COMPANY
1392 West 3rd Street
Cleveland 13, Ohio

† ANUM-METL Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES

Reducing Valve

No. 80 Series Trap

Strainer

STRONG

The RIGHT INSULATION correctly applied NEVER GROWS OLD

Selecting the Right Insulation: Any insulation will save *some* money—but only the right insulation, correctly applied, will save the *most* money for the longest period of time. Because of its many advantages, leading refrigerating engineers have long relied on J-M Rock Cork Insulation for refrigeration service.

Correct Application: No insulation is better than the man who installs it. That's why every J-M Insulation Applicator is a skilled mechanic thoroughly trained in all phases of up-to-date application methods.

26 Years Young: J-M Rock Cork Insulation was used to insulate this 40′ x 60′ cold storage room of the Defiance Grocery Company, Defiance, Ohio, back in 1921. Because the job was *engineered right* and *applied right,* it is still providing dependable service.

If you would like to have a J-M Insulation Engineer help you with your next insulation job, write Johns-Manville, Box 290, New York 16, N. Y.

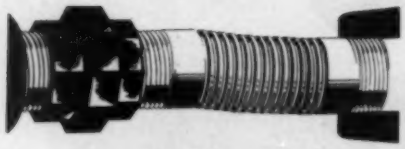
JM

Johns-Manville ROCK CORK

Calling all JOBBERS!

10" x 14" EYE CATCHING COUNTER CARD

The Fast Selling Paracoil FLEXIBLE NIPPLES



THEY BEND!

are back again!

THE "PARACOIL" FLEXIBLE NIPPLES have always been one of the fastest moving items on the jobber's shelves. Every steamfitter and plumber that ever used them knows how they lick the problem of the "cockeyed" tapping, and the out-of-line pipe run. Now available once more, shipments are breaking every previous record!

Helping to keep these fittings moving from jobber to contractor are some of the most striking sales aids ever used for a plumbing or steamfitting specialty. Large 4-color counter cards and explanatory stuffers that stop and sell at a glance, are available FREE to every jobber that stocks these items. They are proven profit makers!

Write today for details—your customers will thank you for handling the line.

Flyers for your counter and direct mail are part of our sales aid.

DAVIS
ENGINEERING CORPORATION
1064 East Grand Street, Elizabeth 4, N. J.

NEW BOOKS & REPORTS

ACRMA Compiles Air Conditioning Standards

Prepared primarily as "recommended practice" for ACRMA members, comprising principal equipment manufacturers, a 16 page booklet, Application Engineering Standards for Air Conditioning for Comfort, incorporates text and tables covering design load factors, design outside and inside conditions, sunlight radiation through glass, ventilation and infiltration, design occupancy, heat gain from occupants and appliances, transmission coefficients, air distribution, and capacity specifications. The section on load calculations provides a simplified cooling load calculation form. Also included is a section on heating loads, with a short form for heating load calculations.

The Association states, "These recommended standards were designed not to supplant, but rather to supplement, individual company practice and data prepared and published by technical societies. In compiling these recommended standards, the members of ACRMA used as bases not only authoritative published material and generally accepted industry practice, but also their own practical experience in the application of the industry's products."

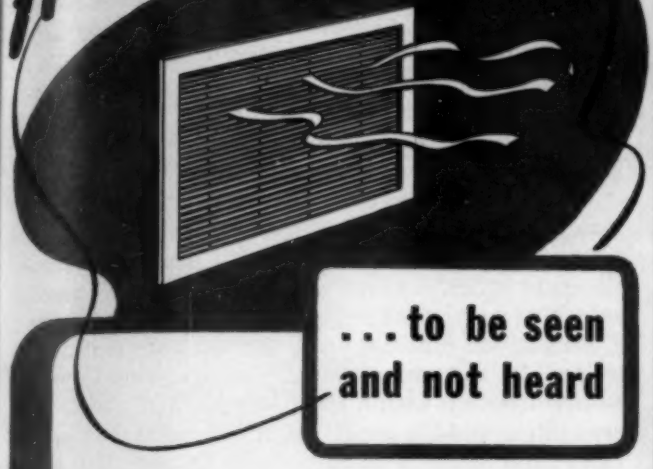
This new publication is priced at $1.00, with a schedule of discounts for quantity purchases. It may be obtained from headquarters of the Air Conditioning and Refrigerating Machinery Association, Southern Bldg., Washington 5, D.C.

Cast Bolts for Pipe Joints Economically Mass-Produced

Cast bolts for pipe joints are not only economically mass-produced by the use of metal molds and short cycle annealing, but they have desirable mechanical and corrosion-resistant properties, according to C. K. Donoho, chief metallurgist, American Cast Iron Pipe Co. His paper, Cast Bolts for Pipe Joints, which was contributed by the metal engineering division of the American Society of Mechanical Engineers, was presented at the recent semi-annual meeting of the society and published in the September issue of Mechanical Engineering.

The author briefly outlines the primary qualifications for pipe bolts by listing high yield strength, toughness and ductility sufficient to withstand ordinary shock and bending stress, and corrosion resistance equal to or better than the pipe with which it is used. Some of the advantages and disadvantages of bolting materials commonly used for cast iron pipe joints, according to the author, are: (1) mild steel bolts have the requisite strength and toughness but may be low in yield strength so that in tightening, they may be stressed beyond the yield point. This may result in continued stretching after the joint is made, permitting it to leak; (2) steel bolts may fail because of corrosion before the pipe has been affected. Galvanizing or cadmium plating affords only temporary protection in aqueous or underground corrosive environments; (3) regular malleable iron bolts are low in yield strength and are as corrodible as steel, though high strength pearlitic, malleable bolts, alloyed

AIR CONDITIONING



. . . to be seen and not heard

When you need ribbons on the ducts to show your air conditioning in operation —then noise and vibration have successfully been eliminated.

And Korfund Vibration Control assures you of this important benefit. Engineered especially for your needs, Vibration Control prevents disturbance caused by machinery in motion.

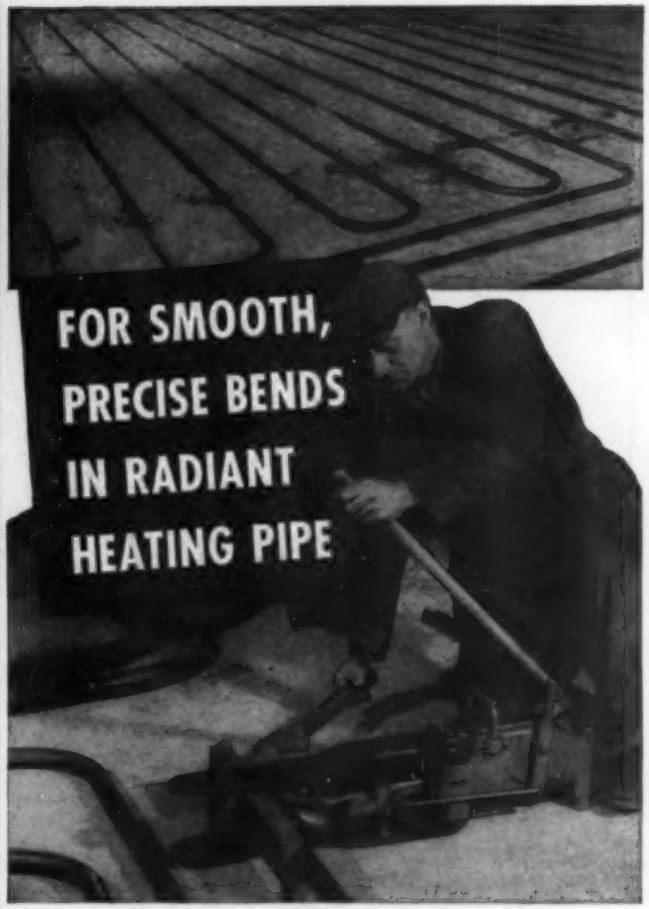
Korfund designs Vibration Control for fans, blowers, compressors and for complete units. For really satisfactory air conditioning—the kind that takes ribbons —consult Korfund for Engineered Vibration Control.

The Korfund Co., Inc., is sole distributor of Armstrong Standard Density Vibracork in 2" to 4" thicknesses. Write for complete details.

Korfund Type LK/C is an inexpensive steel spring Vibro-Isolator with resilient chocks at the corners to act as stabilizers.

KORFUND
VIBRATION CONTROL

THE KORFUND COMPANY, Inc., 48-36 32nd Pl. LONG ISLAND CITY 1, NEW YORK



● Install radiant heating pipe the swift, sure way... with the GREENLEE 770-R Hydraulic Pipe Bender which makes precise 90° and return bends in *cold* pipe of sizes ½" through 2".

After making the above illustrated radiant installation with the aid of a GREENLEE, Bilz Plumbing and Heating Co., Spring Lake, Michigan, reported as follows. "One man operates the GREENLEE Bender easily *and fast*, thus providing a tremendous saving in labor hours."

"There's no flattening of pipe with a GREENLEE Bender, it brings substantial savings in fittings and manufactured bends. And, most important, there is *much less friction loss* in the system with curve bends instead of regular square fittings."

Do the job easier, faster, *better* with a GREENLEE. One-man-operated, compact, portable for on-the-job work. Two models for pipe from ½" to 4½". Write for details. Greenlee Tool Co., Division of Greenlee Bros. & Co., 2350 Twelfth Street, Rockford, Illinois.

REGISTERED TOOLS
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FOR THE CRAFTSMAN

ONE-STOP BURNER SERVICE

JOHN ZINK BURNERS

John Zink and His Engineers Offer You . . .

- their ability to design and adapt special burners for special boiler installations.
- their research laboratory to make accurate tests on any type of small boilers, and burners, in order that you may know the proper specifications and performance your particular installation requires.

John Zink also manufactures Gas Burners, Oil Burners, and Combination Oil and Gas Burners for: Domestic Boilers, Heating Boilers, Industrial Boilers and Power Boilers. We are willing and capable of designing and manufacturing special burners for special purposes.

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for corrosion resistance, have given satisfactory service; (4) bronze and stainless steel bolts may be used for the most severe conditions but are relatively expensive.

Mr. Donoho then describes the metallurgical development, production, and properties of his company's alloy, cast iron bolt which has been developed principally for use in mechanical joints in cast iron pipe lines for conveying liquids and gases. The metal is melted in a cupola and cast into individual molds to form the bolt blank. Quick freezing by reason of the chilling action of the mold is said to cause the metal to cast "all white" (essentially with no free carbon). Subsequent heat treatment is designed to convert the iron to a malleable structure which is strong and tough, yet easily machinable. The metal mold process is said to permit the use of a composition different from the ordinary cupola malleable, and the compositional changes permit complete malleableization with a short anneal. The use of 3 per cent silicon and 1¼ per cent copper in solid solution provides high strength and hardness values. The copper content in solution, in both bolts and nuts, is said to make the bolt-nut combination slightly cathodic to unalloyed iron or steel in a conducting environment. Since electrochemical corrosion currents generally run from pipe to bolts and not in the reverse, the bolts, in effect, are protected cathodically. In strong acids corrosion occurs more by direct chemical action, and the copper content of these nuts and bolts aids corrosion resistance.

Revises Standards on Steam Jet Ejectors and Vacuum Cooling

Important revisions in the standards of the Heat Exchange Institute are contained in the second edition of its steam jet ejector and vacuum cooling section standards.

The new publication contains three parts bound in one book. Part one contains recommendations on nomenclature, operating principles, types of assemblies, capacity, and standard accessories and materials of construction. The test code for steam jet ejectors, part two, has been considerably revised, and contains new steam flow curves based on the latest available data; a revised critical pressure ratio curve; recommendations covering measurement of motive steam, condensing water, pressure, and capacity; information on performance tests; revised illustrations of HEI standard flow nozzles; official HEI orifice capacities; revised diagrammatic arrangements of apparatus for conducting various tests; and air water vapor mixture data. Part three on steam jet vacuum refrigeration equipment contains recommended definitions, nomenclature, performance, construction, standard units, and special types.

Price of the revised publication is $1.00 per copy, and it may be secured from the office of the Secretary: C. C. Rohrbach, 90 West St., New York 6, N. Y. On quantity orders for students use, and on orders from booksellers, the price is 75 cents per copy, plus delivery charges.

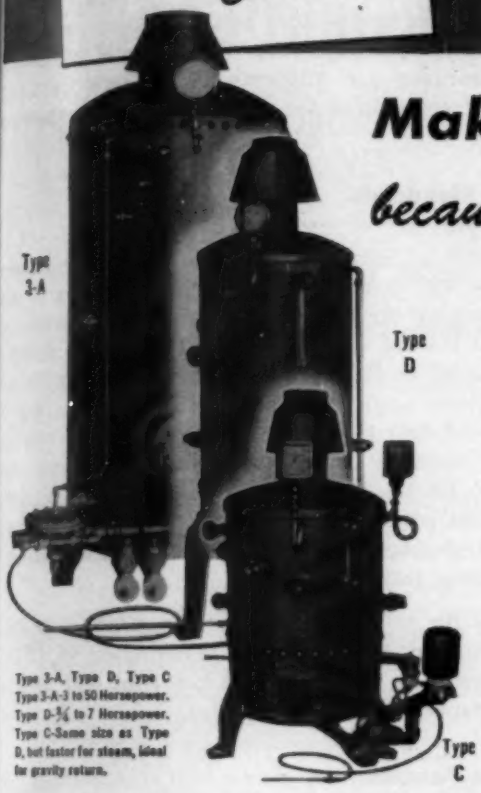
ASA Issues New Listing of 874 Standards

An entire new listing of its 874 standards is now available free of charge at the American Standards Association and may be obtained from their office, 70 E. 45th St., New York 17, N. Y.

Mr. Heating Contractor:

McKEE AUTOMATIC Gas Fired

"STEAMBOILERPLANTS"



Type 3-A, Type D, Type C Type 3-A-3 to 50 Horsepower. Type D-3½ to 7 Horsepower. Type C-Same size as Type D, but faster for steam, ideal for gravity return.

Make More Money for YOU

because

1. — McKee Eclipse Boilers are built "Better Than Code". They require little service, so you *keep* the profits you make!
2. — Being Gas-fired, they produce Hot, Dry Steam, FASTER, for many applications from garment pressing to chemical plant processing.
3. — They supply Steam "RIGHT-AT-THE-JOB"— close to the application; save space; save steam; save money for your customers.
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Write for complete details on STEAMBOILERPLANTS and our co-operation with Heating Engineers and Contractors.

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ECLIPSE FUEL ENGINEERING COMPANY

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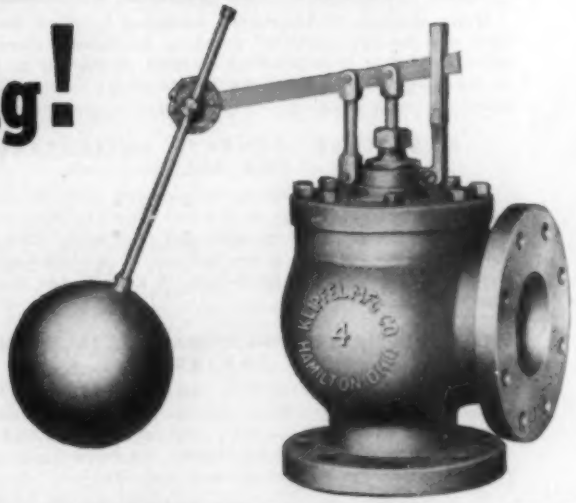
If it's for Gas—buy Eclipse

Facts about float valves...

YOURS for the asking!



KLIPFEL Float Valves assure reliable, constant liquid level control.

Over 40 years of valve selection experience is condensed into the 16 pages of our Bulletin No. 344.

Why not write for it today? It's yours for the asking.

Klipfel

AUTOMATIC REGULATING VALVES

HAMILTON, OHIO

KLIPFEL MANUFACTURING CO., Dept. C-10, Hamilton, Ohio

Please send me Bulletin No. 344, without obligation.

Name_____

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Company_____

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MAGNETROL provides today's most dependable method of pump control, low water fuel cut-off and low water alarm. *It's simple, positive, foolproof!* That's because changes in water level are transmitted to the switching mechanism by magnetic action. *There are no bellows . . . no stuffing box . . . no diaphragms . . . no electrodes!*

Float-actuated piston has no mechanical or electrical contact with switch. MAGNETROL'S highly dependable performance is proved by use in every type of plant *under all conditions.* MAGNETROL is the guiding hand on every Schaub Boiler Return System . . . *and can be used with any electric boiler feed pump for greater reliability.*

NEW "UNITARY" SWITCHING MECHANISM

Quick changes in Magnetrol's operating functions are possible with the new "Unitary" switching mechanism. Completely self-contained, it is installed or replaced on the job as simply as changing cells in a flashlight. Switch spacing and level differential are easily adjusted. *No special tools or skill are required.*

MAGNETROL STANDARD MULTI-STAGE CONTROLS

Model 251 (illustrated above) for pressures up to 250 lbs. . . . Model 126 for pressures up to 125 lbs. Normally, these provide 2-stage control. Upper stage starts and stops boiler feed pump. Lower stage controls low water fuel cut-off or alarm—*or both.* A third level stage can be added, if desired, for two-stage pump control.

MAGNETROL COMBINATION WATER COLUMN & CONTROL

Models W-126 and W-251 for pressures of 125 and 250 lbs. respectively. A longer float chamber has tapped outlets for gauge glass and three try-cocks, and conforms to ASME Code water column design. These models therefore combine the functions of both water column and controller.

MAGNETROL SINGLE-STAGE CONTROL

Model 249 (pressures up to 250 lbs.). Ideal for low water cut-off and/or alarm function only.

Write for Bulletin 147 and full information on Magnetrol Boiler Water Level Controls.

MAGNETROL, Inc.

A Division of Fred H. Schaub Engineering Co. Inc.

2116 S. Marshall Blvd. Chicago 23, Illinois

The new listing includes prices which are revised slightly upward, because of increased production cost, and a number of additional revised standards approved since the January 1947 issue of all American Standards. Under the new price listing a complete set of all American Standards comes to $200.00, and a complete set of all American Safety Standards costs $32.50 a set. Customary quantity discounts are allowed in the new catalog. These range from 20 to 45 per cent for various quantities up to 1000.

Iron Valve Standards Now in Print

Printed copies of Simplified Practice Recommendation R184-47, Iron Valves, are now available, according to an announcement by the commodity standards division of the National Bureau of Standards. The recommendation, first issued in 1942, applies to the usual types of iron gate, globe, angle, and check valves for primary pressures of 25, 125, 150 and 250 lb and 100 and 800 lb pressures of water, oil, and gas. A simplified range of sizes is given for the various types and kinds of valves for each of the pressure ratings. It will serve as a useful standard of practice in the production, distribution, and use of these valves.

Copies are for sale by the Superintendent of Documents, Government Printing office, Washington 25, D. C., for 5 cents each. A discount of 25 per cent will be allowed on orders of 100 or more copies.

ASRE Issues Pamphlet on Conditioning for Candy Plants

The candy industry has found that the proper control of temperature and humidity is vitally important. The use of air conditioning to eliminate changing atmospheric conditions and their adverse effect on production is described in a new pamphlet, Air Conditioning in Candy Manufacture, Application Data 39, published by the American Society of Refrigerating Engineers.

Prepared by H. C. Hoffmann of the Carrier Corp. and formerly chairman of the society's air conditioning committee, the pamphlet contains information on cooling tunnels, cold rooms, hot rooms, revolving coating kettles, methods of supplying refrigeration, and miscellaneous operations of candy manufacture.

The four page leaflet may be obtained from ASRE headquarters, 40 W. 40th St., New York City. The price is 20 cents.

Other Books and Reports Received

Supplement No. 2 to the 1942 Edition of the American Standards Code for Pressure Piping, designated as ASA B31.1b-1947, available from American Standards Association, 70 E. 45th St., New York 17, N. Y., or from the sponsor, American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y. Price, 60 cents per copy. Major changes in the supplement consist of additions covering instrument and control piping to each section of the code, changes in the formulas for the determination of minimum pipe wall thickness in all sections, and revision of the minimum temperature for cast iron refrigeration valves and fittings from -60 to -100 F.

45 INDUSTRIES solve Venting Problems with TRANSITE INDUSTRIAL VENT PIPE

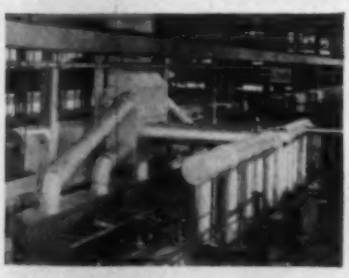
Survey shows plant engineers specify this asbestos-cement pipe for longer life, less maintenance

REPORTS FROM 45 industries indicate more and more plants rely on Transite Industrial Vent Pipe to carry off corrosive fumes, gases, vapors, dust, and smoke.

The reason, J-M engineers state, is that Transite Vent Pipe is made of asbestos and cement combined by a special process . . . has a high resistance to many corrosive conditions typical of industrial operations. Plants that formerly had to replace vent pipe at frequent intervals often get years of efficient service from Transite . . . with practically no maintenance costs.

Because this vent pipe is completely rustproof, it may be used for vents and stacks without protective painting. Light in weight and readily assembled, Transite Industrial Vent Pipe comes in sizes from 3" to 36" in diameter. A full line of Transite fittings assures corrosion resistance throughout the system.

J-M engineers will be glad to consult with you about the use of Transite Industrial Vent Pipe as a possible solution to your venting problems. Ask for Data Sheet series, DS-336. Johns-Manville, Box 290, New York 16, N. Y.



A typical installation of Transite Industrial Vent Pipe venting corrosive gases, vapors and fumes from a large industrial plant.

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Typical Industries in which Transite Industrial Vent Pipe is used

Aircraft	Foundry	Quarrying
Automobile	Furnace	Railroad
Baking	Furniture	Rayon
Bleaching	Gas	Refrigeration
Boiler Works	Glass	Rubber
Brewing	Laboratory	Sewage Works
Canning	Laundry	Shipbuilding
Ceramic	Leather	Shoe
Chemical	Meat Packing	Smelting
Dairy	Metal	Soap
Drug	Mining	Soft Drink
Electrical	Paint	Sugar Refining
Explosive	Petroleum	Textile
Farm Machinery	Potash	Tool
Food	Pulp & Paper	Water Works

As advertised in TIME and NEWSWEEK

New space-saving filter cleans up to 61% more air

A TRICKY PROBLEM encountered by ventilating engineers is filtering a large volume of air where space for filter panels is limited. Often standard filters just won't do. But Air-Maze has the answer—the new P-5 high-velocity filter.

It operates at "coil" velocities up to 600 f. p. m., instead of the standard 350. Makes it possible to use ⅓ fewer filters for many industrial, commercial and railroad ventilating jobs. Usually eliminates need for V-Bank assemblies. Cuts air-cleaning cost to an all-time low.

THE P-5 WORKS HARDER than most types of filters. Its exclusive filter media design causes 3 changes of direction in air flow. Over a million tiny openings in every 20 x 20 panel literally "scrub" the air free from dust, dirt, and impurities, causing them to deposit evenly on viscous-coated wire baffles. Yet the "Z" shaped channels (see illustration) provide large open areas for dirt storage so that flow of cleaned air is almost unimpeded. Result: More clean air, less servicing than ordinary filters. Filters are all-metal, permanent, easily cleaned.

Other Air-Maze filter panels are available to meet a wide variety of specific requirements:

GREASTOP® FILTERS to prevent grease nuisance and fire hazard in kitchen ventilating ducts.

KLEENFLO® FILTERS for recirculating air systems, unit ventilating cabinets. Moderately priced.

WATER ELIMINATOR PANELS for industrial use where entrained water must be removed from the air stream.

INDUSTRIAL FILTERS (Types "A", "B" and R-72) for heavy duty ventilating jobs and for protecting engines and compressors from abrasive effects of dust and grit.

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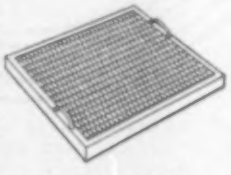
HAVE YOU A FILTERING PROBLEM? Whatever it is, put it up to Air-Maze, the Filter Engineers. Whether you build or use engines, compressors, air conditioning and ventilating equipment, *or any device using air or liquids*—the chances are there is an Air-Maze *engineered* filter to serve you better. Write Air-Maze Corporation, Cleveland 5, Ohio.



P-5 FILTER PANEL

AIR-MAZE

The Filter Engineers

Other Books and Reports Received (Cont.)

Conduction of Heat in Solids, by H. S. Carslaw, emeritus professor of mathematics, University of Sydney, and J. C. Jaeger, lecturer in mathematics, University of Tasmania. Contains some 400 pp, is cloth-bound, priced at $8.00, and is published by the Oxford University Press, 114 Fifth Ave., New York 11, N. Y. Carslaw's Introduction to the Theory of Fourier's Series and Integrals and the Mathematical Theory of the Conduction of Heat, published in 1906, and his Introduction to the Mathematical Theory of Conduction of Heat in Solids, published in 1921, have been extended and brought up to date in this completely new mathematical text which contains a comprehensive treatment of the Laplace transformation method of dealing with heat conduction.

Fluid Flow in Pipes—Its Formulas, Physical Properties and Their Dimensions, by C. H. McClain. Published by the author, 21 W. Wilmot Ave., Havertown, Pa., and designated as Technical Bulletin No. 21-A. This is an abridged edition of the author's Fluid Flow in Pipes and its Dimensional Analysis. Written as a treatment of the theory and practice of fluid flow in pipes from a dimensional viewpoint, it provides more detailed information than is usually found in handbooks. The booklet has 30 pp, 8½ x 11 in., is paper covered, and is priced at $1.00 per copy.

Refrigeration of Ships' Stores, by C. B. Albright, R. A. Chadburn, and J. W. Geddes. The application of refrigeration for the preservation of food on shipboard is described in this six page pamphlet, designated as Refrigeration Engineering, Application Data 28, published by the American Society of Refrigerating Engineers, 40 W. 40th St., New York City. Copies may be obtained from ASRE Headquarters for 30 cents each.

Learning to Weld, published by Lincoln Electric Co., Cleveland 1, Ohio, contains 32, 5½ x 8½ in., pages and 83 illustrations, is paper covered and is priced at 25 cents per copy in the U. S. A., elsewhere, 35 cents each. Provides a simple basic approach for anyone interested in making a start in arc welding. Its purpose is to teach how to weld and to assist in applying arc welding to the repair of broken parts, the hard surfacing of worn parts, and the building of miscellaneous equipment.

Condensation of "Freon-12" with Finned Tubes, by D. A. Katz, R. E. Hope, S. C. Datsko, and D. B. Robinson was presented at the 42nd annual meeting of the American Society of Refrigerating Engineers. Condensing coefficients for "Freon-12" were measured on six different finned tubes and one plain tube. The film coefficients for condensing "Freon" were found to vary from 208 to 425 Btu per hr per F per sq ft of finned area depending upon the tube and the temperatures involved. The data have been analyzed and shown to be in general accord with the Nusselt theory of condensation modified for finned tubes.

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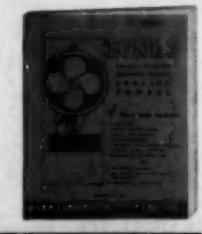

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due to dirt and lime in your water when you install the new A-P Model 68-B Water Regulating Valve on your water-cooled condensing units. A radically different construction principle actually "cleans itself," employing a molded composition seal on the valve stem which moves across the polished mirror-smooth stainless steel seat with an effective "wiping" action. Laboratory tested in sandy water, this unique sliding seal and seat showed no sign of water after the equivalent of many years use — proof of "lifetime" of accurate water regulating service.

With an operating head pressure of 50 to 150 p.s.i. Model 68-B can be easily adjusted to your system through the wide port in the body. Its long stroke provides closer, more uniform control without chattering or water-hammer. Three sizes, ⅜", ½" and ¾" inlet and outlet, offer a wide range of utility on Freon, Methyl Chloride or Sulphur Dioxide systems. Buy it today at your leading Refrigeration Jobbers — or write for bulletin No. M100.

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FOR AIR CONDITIONING • REFRIGERATION • HEATING

MEETINGS & CONVENTIONS

Industrial Hydraulics Conference Sponsored by Armour, Others

The third annual meeting of the National Conference on Industrial Hydraulics will be held October 16 and 17 at the Hotel Continental in Chicago. The conference is sponsored by Armour Research Foundation and the graduate school of Illinois Institute of Technology in cooperation with the Chicago sections of the SAE, ASCE, and ASME.

Additional information may be obtained from Dr. V. L. Streeter, Armour Research Foundation, Technology Center, Chicago 16, Ill.

Welding Meeting, Exposition to Be Held Concurrently

The American Welding Society, 33 W. 39th St., New York City, will gather for the 28th annual meeting to be held October 19-24 at the Hotel Sherman, Chicago, during the National Metal Exposition. A total of 70 papers covering 16 classifications of welding applications and research will be presented at the 20 technical sessions during the week.

In addition to the technical sessions of the Society there will be welding and cutting exhibits at the Exposition, to be held at the International Amphitheatre, Chicago. This exposition has been extended to run a full week starting October 18. It will be open from n noon to 10:30 p.m., October 18 to 22, inclusive, an from 10:00 a.m. to 6:00 p.m. on Thursday and Friday October 23 and 24.

Chemical Conference to Be Held on West Coast

An industrial chemical conference and display fo the western states and Pacific area are scheduled for th Civic Auditorium in San Francisco, Oct. 21-25. This i the first regularly scheduled Pacific Chemical Exposition and will be presented by the California section o the American Chemical Society, whose headquarters i at the Whitcomb hotel, San Francisco.

Building, Maintenance Products to Be Exhibited in New York

The National Association of Housing Officials, 1313 E. 60th St., Chicago 37, Ill., will hold its 14th annual meeting at the Hotel New Yorker, New York City, November 17 to 20. The second annual exhibit of building and maintenance products will be held simultaneously for this group, composed of executive directors, nonsalaried commissioners, engineers, maintenance superintendents, architects, and other management personnel connected with permanent public housing.

ASME Annual Meeting Scheduled for December

The 1947 annual meeting of The American Society of Mechanical Engineers, 29 W. 39th St., New York City

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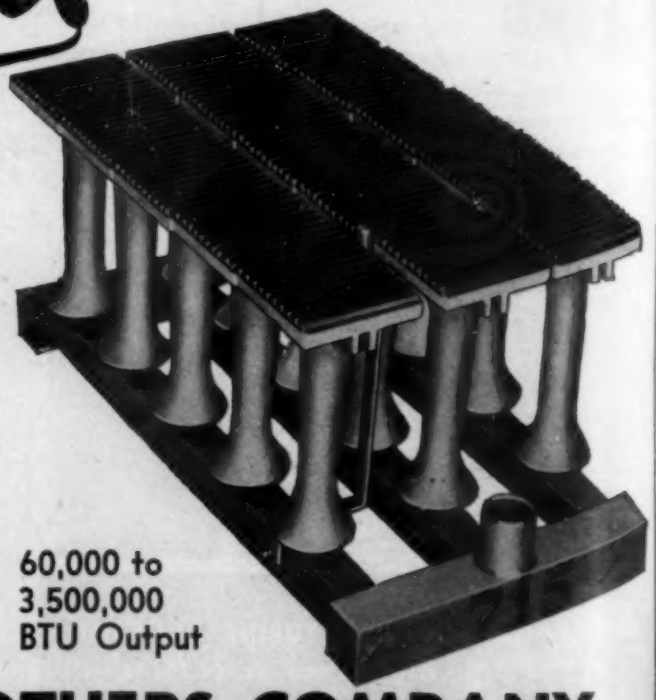

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EXTERIOR, and one of the hardening rooms in new ice cream plant of H. P. Hood & Sons, Charlestown, Mass. The insulation is Novoid Corkboard erected by A. F. Underhill, Inc., Novoid distributor in Cambridge, one of New England's outstanding insulation experts.

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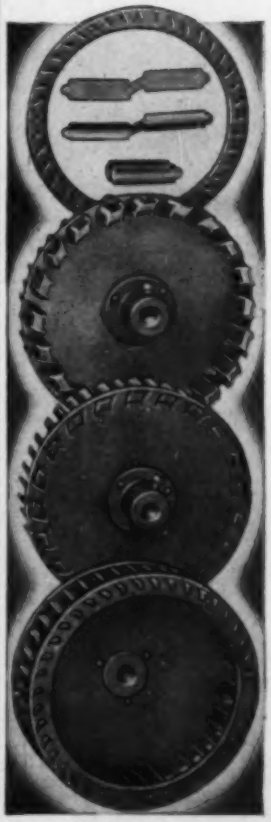
REALLY STURDY BLOWER WHEELS



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The steel inlet, back plate discs and slots are die cut to insure exact spacing of the blades, which are formed in pairs to increase rigidity.

A machined aluminum hub is riveted to the back plate, then the blades inserted into the slots.

Each pair of blades are spot welded to the back plate. The inlet disc is then pressed down over the tips of the blades, which are bent against the inherent spring of the steel and then rolled flat against the inlet disc.

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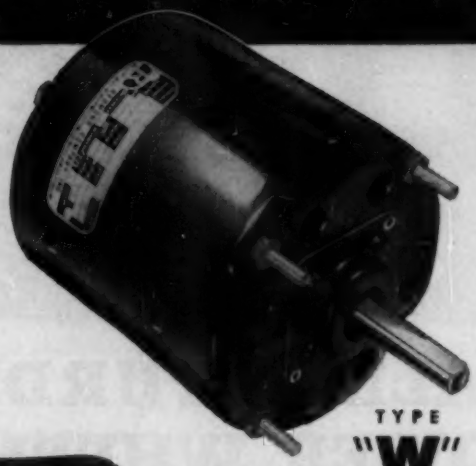

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Expanded facilities. Prompt deliveries. Service before and beyond the sale.

More than 20,000,000 Micromotors have been built for famous products

will be held at the Chalfonte and Haddon Hall hotels, Atlantic City, Dec. 1-5.

Another meeting scheduled this year is that of the fuels division which will be held with the coal division of the AIMME in Cincinnati, October 20 to 22.

Says Hotel Accomodations Adequate for REMA Show

Adequate housing accommodations for persons attending the 5th All-Industry Refrigeration and Air Conditioning Exposition in Cleveland, January 26 to 29, are practically assured according to F. J. Hood, chairman of the show committee. The Refrigeration Equipment Manufacturers Association, sponsor of the show, has arranged to handle all reservations through the Cleveland Convention and Visitors Bureau. Early applications are urged as some trouble may be encountered in obtaining rooms at the last minute.

Heating, Air Conditioning Show to Include New, Improved Products

The 8th International Heating, Ventilating, and Air Conditioning Exposition will be held in Grand Central Palace, New York City, the week of February 2, 1948. Almost every known device for promoting indoor comfort (some new, others strikingly improved) will be presented.

Exhibitors' response to date indicates that all space will be exhausted in advance of the opening, according to C. F. Roth of the International Exposition Co., Grand Central Palace, New York, N. Y., managers of the show.

The exposition will again be under the direct auspices of the ASHVE, and the Society's 54th annual meeting will be held concurrently (see the Society Journal Section in this issue for further details).

OHI Plans for 1948 Convention Progressing

A. E. Hess, managing director, Oil-Heat Institute of America, 6 E. 39th St., New York City, reports that plans are progressing for the 1948 convention and exposition to be held in the Chicago Coliseum during the week of April 5. He also has advised that convention and exposition arrangements have been completed for Boston during the week of May 15, 1949, with a show to take place in Mechanics Hall.

HPACCNA Sets Date for 1948 Convention

The Heating, Piping and Air Conditioning Contractors National Association, Rockefeller Center, 1250 Avenue of the Americas, New York City, has chosen Pittsburgh as its convention city for 1948. The association's 59th annual convention will be held June 1-5 at the Hotel William Penn.

REMA Plans November Exposition for 1949

The 6th All-Industry Refrigeration and Air Conditioning Exposition will be held in Cleveland, the week of November 7, 1949. Announcement was recently made by the Refrigeration Equipment Manufacturers Association, sole sponsor of the show.